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Ozone in Ventilation

2—EXPERIMENTAL RESULTS.

By MILTON W. FRANKLIN.

In view of the contradictory character of the reports already cited and of the generally unsettled conditions of the questions involved, experiments were conducted for the purpose of attaining definite information.

In determining the action of ozone on odors and certain gaseous emanations, the apparatus shown in Fig. 1 was used. This consisted of two bottles of 12 L. capacity with suitable connections, a vacuum pump and an ozonator.

One of the bottles was filled with the emanation the odor of which was to be studied by drawing air slowly over a mass of the material, confined under a bell jar, and thence into the bottle. The other bottle, of equal capacity, was filled with ozonized air. The communication between the two bottles was then established and the two gases permitted to diffuse. After a suitable interval, usually about 48 hours, the emanation mixed with ozone was drawn through a neutral solution of KI to free it of excess ozone, and the remaining gas examined.

Tests with tobacco smoke and with H_2S proved conclusively that these substances were deodorized and that the absence of odor could not be attributed to the presence of ozone. The tests were by smelling and also by lead sulphide in the case of H_2S. I then had further tests conducted with a refined and elaborated technique.

NATURAL FOOD ODORS.

The substances employed in these experiments were onions, garlic and limburger cheese. In each case the materials were finely divided and placed in flasks provided with an inlet and an outlet tube, the former reaching to the bottom of the vessel. 125 c.c. of the effluvium from the flasks were separately collected in 250 c.c. gas collection tubes by displacement of water, with which the tubes were previously filled. The remaining 125 c.c. of water were displaced in one case with ozonized air, and in the other with air. Two tubes were thus prepared with each odor, one containing an addition of ozonized air and the other of ordinary atmospheric air. The tubes were at once clamped in a vertical position and it was then a simple matter to introduce water through the lower stopcock, which thus compressed the gas within the tube.

On opening the upper stopcock and holding the exit tube close to the nostrils, the odor of the gas could be noted. A 10 per cent. solution of ferrous sulphate was then introduced and the tubes well shaken. The ferrous sulphate was immediately oxidized by the residual ozone, the odor of the latter being thereby destroyed. It was, of course, necessary to treat the tube without ozone in the same manner, so that any possible deodorization due to the ferrous sulphate would not be overlooked. After the ferrous sul-

phate was introduced, the odor of the gas was again noted, as in the first instance. The results of these tests were as follows:

	Odor Before Treatment with Ferrous Sulphate Solution.		*Odor After Treatment with Ferrous Sulphate Solution.*	
Odor from:	With air:	With ozone:	With air:	With ozone:
Onions	Strong onion	Strong ozone	Strong onion	None
Garlic	Strong garlic	Strong ozone	Strong garlic	None
Limburger cheese	Strong limburger	Strong ozone	Strong limburger	None

These results show that odors from onions, garlic and limburger cheese are actually destroyed by ozonized air.

DECOMPOSED FOOD ODORS.

In these experiments four different raw food materials were placed in flasks and allowed to decay. The substances employed were fish, eggs, meat and oysters. The effluvium was collected as before and examined in the same manner, before and after treatment with ozone and ferrous sulphate.

sive odors. A series of experiments conducted as before did not give conclusive evidence of these odors and it was necessary to adopt a different procedure in order to determine whether ozonized air destroyed these odors.

The method finally adopted was to impregnate pieces of cheese cloth (12 ins. wide and 36 ins. long) with the odors. This was accompanied by suspending the cloth in a 3-gal. bell jar resting on a ground glass plate lubricated with petrolatum. The substances were vaporized from a watch glass supported on a heated briquette and after two hours a definite volume of ozonized air was

	Odor Before Treatment with Ferrous Sulphate Solution.		*Odor After Treatment with Ferrous Sulphate Solution.*	
Odor from:	With air:	With ozone:	With air:	With ozone:
Decayed fish	Very offensive	Strong ozone	Very offensive	None
Decayed eggs	Very offensive	Strong ozone	Very offensive	None
Decayed meat	Very offensive	Strong ozone	Very offensive	None
Decayed oysters	Very offensive	Strong ozone	Very offensive	None

DEFINITE CHEMICAL COMPOUNDS OF DISAGREEABLE ODORS.

Experiments under this heading were conducted with skatol, valerianic acid and butyric acid. Skatol (C_9H_9N), together with indol (C_8H_7N), are chiefly responsible for the offensive odor of excrements. Valerianic acid has an odor similar to old cheese and occurs free and as ester in cheese, perspiration of the feet and in human feces. Butyric acid is found in sauerkraut, rancid butter and limburger cheese. These substances, therefore, represent types of very offen-

passed through one jar and a similar volume of air through another which served as a control. The cloths were then removed and allowed to air in a well-ventilated room for 24 hours.

This was necessary to remove the residual ozone in those cases where the cloths were treated with ozonized air and the controls were treated in like manner, so that any disappearance of odor could not be attributed to ventilation.

It was found in each case that the cloths impregnated with the odors still retained these after 24 hours, whereas

those treated with ozonized air were free from these odors as well as ozone. It is therefore established beyond all question that the odors of skatol, valerianic acid and butyric acid are actually destroyed by ozone.

OFFENSIVE TRADE ODORS.

The substance treated in this case was a fertilizer, commonly known as tankage,

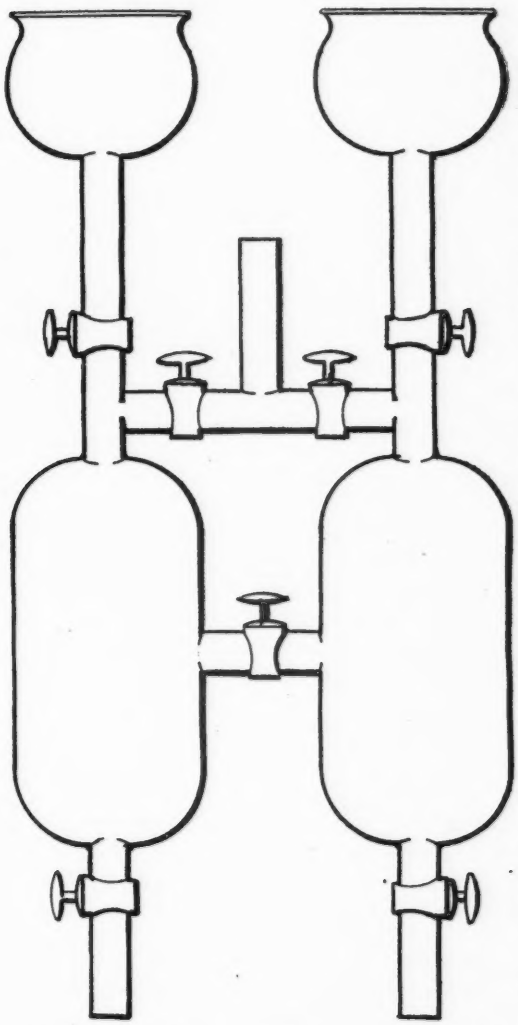

FIG. 1.—OZONE DIFFUSION APPARATUS USED IN EXPERIMENTS.

and is obtained in the treatment of butchers' scrap. It has a very offensive odor. The tests were conducted as before and it was demonstrated that this odor is completely destroyed by ozone.

A number of experiments have also been conducted with odors of common occurrence in dwellings. Among these it has been established that the offensive odor of tobacco smoke, which impregnates the clothing of persons exposed to atmosphere heavily laden with smoke, is also destroyed by ozone. The experiments with tobacco smoke were made by saturating a piece of cheese cloth suspended in a box and blowing the smoke from a pipe into the opening, so that the cloth remained in a dense atmosphere of smoke until it was thoroughly saturated. Ozonized air not only destroyed the odor but also removed the yellow discolorations produced by blowing smoke through cloth.

Conclusions.

1. The experiments described in this report show that ozonized air does not merely mask offensive odors of varied nature, but that it actually destroys them.

2. It is shown that the odor of some common food materials, onions, garlic and limburger cheese are destroyed by ozonized air.

3. The odors resulting from decayed raw food materials, fish, eggs, meat and oysters are destroyed by ozonized air.

4. The offensive odors of fertilizers are destroyed by ozonized air.

5. Several definite chemical compounds which contribute to the odor faces, perspiration of feet, rancid butter, sauerkraut and limburger cheese, namely, skatol, valerianic acid and butyric acid, are also destroyed by ozonized air.

6. The persistent odor of tobacco smoke as absorbed by the clothing is destroyed by ozonized air and the yellow color produced by blowing smoke through cloth is bleached by ozone.

Carbon Monoxide.

In these experiments bottles containing the mixed gases (CO and ozonized air), after standing for a definite length of time, were treated with an oxidizable chemical solution in order to destroy the residual ozone. The gaseous contents of the bottle were then aspirated through wash bottles containing barium hydroxide solution. The bottles were also immersed in warm water in order to drive out any carbon dioxide remaining in the solution.

EXPERIMENT 1.

One bottle containing 50 c.c. of carbon monoxide and filled with ozonized air, together with a control containing ozonized air only, were allowed to stand over night. 100 c.c. of a 5 per cent. solution of potassium ferrocyanide were then added and the contents thoroughly shaken. After aspirating the gas which contains carbon monoxide through barium hydroxide wash bottles, it was found that absolutely no barium carbonate was found, but the potassium ferrocyanide solution was found to be alkaline, thus explaining the phenomena. Before aspirating the controls 5 c.c. of diluted sulphuric acid was added (in order to insure an acid reaction), but in this instance no definite end point could be obtained. It was found that the difficulty was due to the liberation of hydrocyanic acid. The use of this reagent was therefore abandoned and it was decided to use ferrous sulphate, which could not give rise to any disturbing volatile substances.

EXPERIMENT II.

Three bottles were prepared, No. 1 containing 25 c.c. of carbon monoxide; No. 2 50 c.c. and No. 3 was a control containing only ozonized air. After standing over night, 100 c.c. of ferrous sulphate solution, acidified with sulphuric acid (5 c.c. dilute sulphuric acid in 100 c.c. of solution) were added and aspirated as in Experiment 1. Bottle No. 1, containing 25 c.c. of CO, gave 10.7 c.c. CO_2. Bottle No. 2, containing 50 c.c. of CO, gave 4.0 c.c. CO_2. Bottle No. 3, containing no CO, gave 0.4 c.c. CO_2.

The small amount of carbon dioxide obtained in bottle No. 3 was apparently introduced through inefficient washing of the air used in aspiration, but the results were indeed promising. The end point was not as sharp as it should be in bottles No. 1 and No. 2, and on further investigation we found that the slowly precipitated barium carbonate occluded barium hydroxide, thus causing the end point to return after the completion of the titration. When barium carbonate was rapidly precipitated the phenomena was not observed. The error due to occlusion corresponds to approximately 0.25 c.c. of carbon dioxide. This can be obviated by continuing the addition of standard oxalic acid solution until a permanent end point is obtained.

EXPERIMENT III.

This experiment was conducted along the same lines as Experiment No. 2, but the time of exposure was three days in this case.

Bottle No. 1, containing 10 c.c. of CO, gave 8.7 c.c. of CO_2.

Bottle No. 2, containing 25 c.c. of CO, gave 17.1 c.c. of CO_2.

Bottle No. 3, containing no CO, gave 1.8 c.c. of CO_2.

Deducting the blank, the 10 c.c. of CO produced 6.9 c.c. of CO_2 and the 25 c.c. of CO produced 15.3 c.c. of CO_2.

A number of preliminary experiments were made to determine the reaction which takes place between hydrogen sulphide and ozone. It was found that the ozone caused an immediate precipitate of sulphur (giving a milky fluid in the presence of water), which gradually became oxidized to sulphuric acid.

From this it is evident that the reaction of ozone on hydrogen sulphide takes place in two stages. In the first stage sulphur is precipitated and this in turn becomes oxidized to sulphuric acid.

Conclusions.

These experiments demonstrate conclusively that carbon monoxide is oxidized to carbon dioxide by simple contact with ozonized air.

It is also shown that hydrogen sulphide is changed to sulphur and water, the sulphur being further oxidized to sulphuric acid. Hydrogen sulphide possesses a strong characteristic odor resembling that of rotten eggs. The chemical change, which takes place under the action of ozone, results in a destruction of this odor.

Bacteriacidal Action of Ozone.

Numerous experiments to determine the action of ozone on bacteria were conducted. Only a resumé of the results is presented. The ozonator was of a common portable type, found in the American market, and the concentrations of ozone varied from 1 to 10 gm. per cubic meter of air, the difference being accounted for by the varying lengths of the periods of operation and of room sizes.

EXPERIMENT NO. I.

The oxonator, run in an open room of approximately 1,000 cu. ft. for 20 minutes, gave no reduction in the small number of bacteria present.

EXPERIMENTS NOS. II AND III.

The ozonator, run in a closed room of 200 cu. ft. for 30 minutes, removed 95.4 per cent. of the small number of bacteria present. The test repeated, with a very small number of bacteria present in the air, showed the removal of 77.9 per cent. in 30 minutes, and 69 per cent. in one hour.

EXPERIMENT NO. III.

Agar plates streaked with cultures of B. coli and exposed for one hour showed that ozone had a slight inhibitive action.

EXPERIMENT NO. IV.

Although the cotton batting screen over the air inlet may remove large numbers of bacteria from the air, the ozonator without the cotton batting screen was found to be capable of removing a greater number of bacteria entirely independent of cotton.

EXPERIMENTS NO. V AND NO. VI.

B. typhosus, B. coli and staphylococcus pyogenes aureus streaked on agar plates, exposed to the action of ozonator products for six hours, and then incubated at 37° C. for three days, showed a slightly inhibited growth after exposure of four to six hours.

EXPERIMENTS NO. VII AND NO. VIII.

B. typhosus, B. coli and staphylococcus pyogenes aureus, dried on glass rods, and exposed to ozonator products for two hours, showed inhibition to the extent that no growth was visible in the broth culture media until 48 hours' incubation at 37° C. The same organisms were exposed to ozonator products for two hours, while in a moist condition, and then incubated at 37° C. in broth culture media, with the result that all the B. typhosus and B. coli were killed or attenuated so that growth did not appear, and the number of staphylococci killed or attenuated so that growth did not appear until the fourth day of incubation.

All the above investigations were carried on under conditions which were not possible to control on a strictly scientific basis. For example, Experiments 2, 3, 4, 5 and 6 were performed in a small toilet room in which there was a tank of water together with a flush closet. What effect these bodies of water may have had upon the ozone content of the atmosphere of the room was not taken into consideration. Moreover, the room was not of a size or shape likely to be met with frequently in practice, nor were the character of the walls taken into consideration; how much ozone might have been absorbed by the latter is not known.

In Experiments 1, 2, 3, 4, 5 and 6 the ozone apparatus was present in the room in which the investigation was being conducted, whereas in Experiments 7 and 8 the ozone products were led from the ozonator to the experimental apparatus as indicated.

These experiments depended, in large part, upon the bacteria naturally present in the air, and it was found, as might be expected, that the numbers were too small for the results to be considered as clearly indicative of the action of the ozone, or its failure to act.

In the experiments above outlined, especially Nos. 4, 5 and 6, it will be noted that the moist culture media was present in the investigating chamber and undoubtedly absorbed ozone from the atmosphere.

It should also be noted that the preliminary studies, questions of temperature and humidity of the atmosphere at the time of the tests, were not undertaken, it being considered more advisable to eliminate such refinement from the preliminary investigations.

A consideration of the above facts leads to the conclusion that the normal bacterial contents of air may be reduced by the injection of ozone. Failures in this direction are probably due to variations in technique. Dried bacteria on rods, tubes or threads are affected little or not at all by ozone but these constitute no danger to health and their resistance to ozone is of no significance.

It should be noted in this connection that whatever danger there may be from bacteria in the air, it exists only when these are in a state of moist suspension, e. g. droplet infection, and it is in such circumstances that ozone is most effective as a bacteriacide. Czaplewski mentions the drying effect of ozone as

noticed in cold storage plants, and it has been shown above that dry bacteria are comparatively innocuous.

With regard to suspended organic matter in the air, its poisonous nature has not been conclusively proven, but its prominence in the capacity of a nuisance in vitiated air is self-evident and it has been sufficiently demonstrated that ozone destroys organic odiferous particles in the air. Ozone is therefore an aerial detergent and from an aesthetic as well as from a sanitary point of view its use is fully justified.

Aside entirely from all theoretical aspects, we must give some consideration to the results obtained in practice. Bass has experimented with reduced air supply through individual ducts in school ventilation and has shown that the addition of a small amount of ozone to the air greatly lessens the amount required for comfort. Leonard Hill states that the ventilation of the London tubes has been greatly improved by ozone and that the smell has been much less and the air improved in every way since its introduction. Instances of the successful employment of ozone in ventilation are too numerous to mention and have been given wide publicity of late. In the tubes of the Hudson and Manhattan Railway, there is a point at which there has been some trouble from disagreeable odors arising from the seeping in of sewage. A trial installation has shown that this odor, which was unamenable to treatment by any degree of air flushing, could be totally and conveniently eliminated by ozone and a modern ozone plant has recently been installed.

A practical example of the destruction of organic odors by ozone is afforded by a fish glue factory where recently some observations were made. The emanations from a caldron of boiling fish scrap are passed through water and thence by a stack into the air. The resulting vapor is very offensive as the fish scrap is often in an advanced state of fermentation. The injection of ozonized air into the base of the stack rendered the vapor totally unobnoxious; it resembled a clean sea fog.

I have endeavored to show that the dangers of vitiated air are due to heat, moisture and organic contents and that the latter, whether poisons or only odors, constitute a real nuisance. The first two factors may be compensated for by stirring the air and providing sufficient new air to absorb the heat and moisture. The average perspiration of a man is roughly 40 gm. per hour and this amount would saturate approximately 3 cubic meters (100 cu. ft.) of air at 65° F. (18.3° C.). This amount of air would supply more than sixty-eight times the oxygen consumed by a man. The specific heat of air is about 0.24 so that the 100 cu. ft. of air would require approximately 8.8 Cals. to raise its temperature 1° C. Thus by simple calculations the amount of air necessary in any circumstances may be computed.

Odors may best be removed by ozone. The frequent assertion that they constitute only an index of bad air is not substantiated unless it can be proven that there exists a new, and at present unknown, danger in vitiated air. Certainly we need no vicarious indicator of heat and humidity, so that smell exists only as a discrete independent offense, or it is the indicator of organic poison. If the former, it should be removed, and if the latter, it should be destroyed.

Conclusions.

(1) Ozone is a valuable accessory to ventilation.

(2) It is applicable wherever mechanical ventilation is required and in general wherever organic odors are generated.

(3) Ozone destroys, rather than masks, organic odors.

(4) In breathable concentrations ozone inhibits the growth of micro-organisms in the air only slightly, if at all.

(5) Conflicting results obtained in laboratory experiments can be attributed to diversity of methods.

(6) Practical results of actual applications of ozone have been uniformly favorable.

Figuring Pipe Sizes for Hot Water Heating Apparatus

A Method for Gravity Work in Which the Velocity of Flow Determines the Formula to be Used. With Chart for Figuring Hot Water Piping.

By I. V. Serginsky, C. E.

The old Weisbach formula, which has been in general use for many years, determines the friction head for the flow of water in straight iron pipes as

$$P = \frac{1 \times f}{d} \times \frac{v^2}{2g} \quad \ldots\ldots\ldots (1)$$

where P = friction head in meters of water column.

l = length in meters of straight pipe.

f = factor of friction, which, according to Weisbach equals $0.0144 + \frac{0.0095}{\sqrt{v}}$

v = velocity of flow in meters per second.

d = internal diameter of pipe, in meters.

g = acceleration due to gravity = 9.18 meters per second.

In this formula f was determined many years ago by Weisbach from experiments on *cold* water. The modern experiments made by Doctor of Engineering R. Biel on both cold and hot water, published in 1908 in *Zeitschrift des Vereins Deutscher Ingenieure* showed that the formula (1), given above, was very imperfect, and also that at the present state of our knowledge, it is impossible to embody flow of water in pipes in a simple formula, but that the friction head may be expressed by way of three formulas, all different, the application of each formula being dependent upon the velocity of the flow. One formula holds true so long as the velocity of flow keeps below a certain limit, but as soon as the velocity steps over that limit, another formula is to be used to correctly express the friction head, and this again so long as the velocity of flow keeps below the second limit, after which the third formula is used to express the head of friction.

The velocity of the flow, therefore, will determine which formula is to be used. The two velocity limits might be called "critical velocities"—lower critical velocity and upper critical velocity. Both have been found experimentally and embodied in formulas.

Influence of temperature upon the friction head, which having been first introduced by a French scientist, Poiseulle, was proven by experiments of R. Biel, is allowed for in the formulas of both friction head and critical velocities, together with the factor of viscosity.

The lower critical velocity may be expressed as

$$v_l \times 0.305 = \frac{0.204 \times 0.006}{\frac{d}{12} \times 0.305}$$

$$v_l = \frac{0.158}{d} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where d = diameter of pipe in inches.

v_l and v_u = feet per second.

Upper critical velocity may be expressed as

$$v_u \times 0.305 = \frac{11.2 \times 0.006}{\sqrt{\frac{d}{12}} \times 0.305}$$

$$v_u = \frac{1.382}{\sqrt{d}} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Gravity Circulation.

Taking up the formula expressing friction head, as long as the velocity of flow keeps below v_l (formula 2) the friction head may be expressed very accurately as

$$\frac{P}{12} \times 0.305 = 0.0003262 \times \frac{1 \times v \times (0.305)^2 \times 0.006 \times 144}{d^2 \times (0.305)^2}$$

$$\text{or } P = 0.0111 \times \frac{1 \times v}{d^2} \quad \ldots\ldots\ldots (4)$$

where P = friction head in inches of water column.
l = length of pipe in feet.
d = internal diameter of pipe in inches.
v = velocity of flow in feet per second.

or, taking the weight of 1 cu. ft. of water at mean temperature—flow 180° F. and return at 144° F.—equal to 61 lbs.,

$$\frac{P \times 12}{61} = 0.0111 \times \frac{lv}{d^2}$$

$$\text{or} \qquad P = 0.05643 \times \frac{lv}{d^2}$$

where P = pounds per square foot.

Now, so long as the velocity of flow keeps between v_l and v_u the friction head could be expressed approximately, but accurately enough for practical purposes, as

$$P = \frac{lv^2}{d} \times 0.1757 \times \left(0.33 + \frac{0.226}{\sqrt{d}}\right) \quad .(5)$$

where P = friction head in inches of water column.
l = length of pipe in feet.
d = diameter of pipe in inches.
v = velocity of flow in feet per second.

$$\text{or P lbs. per square foot} = \frac{lv^2}{d} \times 0.893 \times \left(0.33 + \frac{0.226}{\sqrt{d}}\right)$$

When the velocity of flow reached v_u and keeps on going higher, the friction head could be expressed very accurately as

$$P = \frac{lv^2}{d} \times 0.1757 \times \left(0.12 + \frac{0.226}{\sqrt{d}} + \frac{0.288}{v\sqrt{d}}\right) \quad \ldots.(6)$$

$$\text{or P lbs. per square foot} = \frac{lv^2}{d} \times 0.893 \times \left(0.12 + \frac{0.226}{\sqrt{d}} + \frac{0.288}{v\sqrt{d}}\right) \quad \ldots.(6)$$

Formulas (4), (5), and (6) hold true for circulation of water in iron pipes commonly used for domestic engineering purposes.

In further developments we shall have to know what must be the velocity of flow of water in pipes in order to transmit a given number of B. T. U. per hour. Taking the weight of 1 cu. ft. of water at mean temperature—flow being 180° F. and the return at 144° F.—for 61 lbs., we can write

$$\tfrac{1}{4} \times (d/12)^2 \times 3.14 \times v \times 60 \times 60 \times 61 \times 36 = \text{B. T. U. per hour} \ldots (7)$$

where d = inches.
v = feet per second.

or v ft. per second

$$= \frac{\text{B. T. U. per hour}}{3{,}600 \times 36 \times 61 \times (d/12)^2 \times 3.14 \times \tfrac{1}{4}} \quad (7)$$

or v ft. per second

$$= \frac{\text{B. T. U. per hour}}{43{,}096 \times d^2} \quad \ldots\ldots\ldots (7)$$

How to Plot the Curve or How to Make a Chart.

The accompanying curves are plotted on logarithmically-divided paper which was found the most convenient, because the curves then become straight lines in the part which corresponds to the same formula.

One could hardly think of a radiator smaller than 1,000 B. T. U. per hour, so that the chart, therefore, shows the smallest quantity of B. T. U., equal to

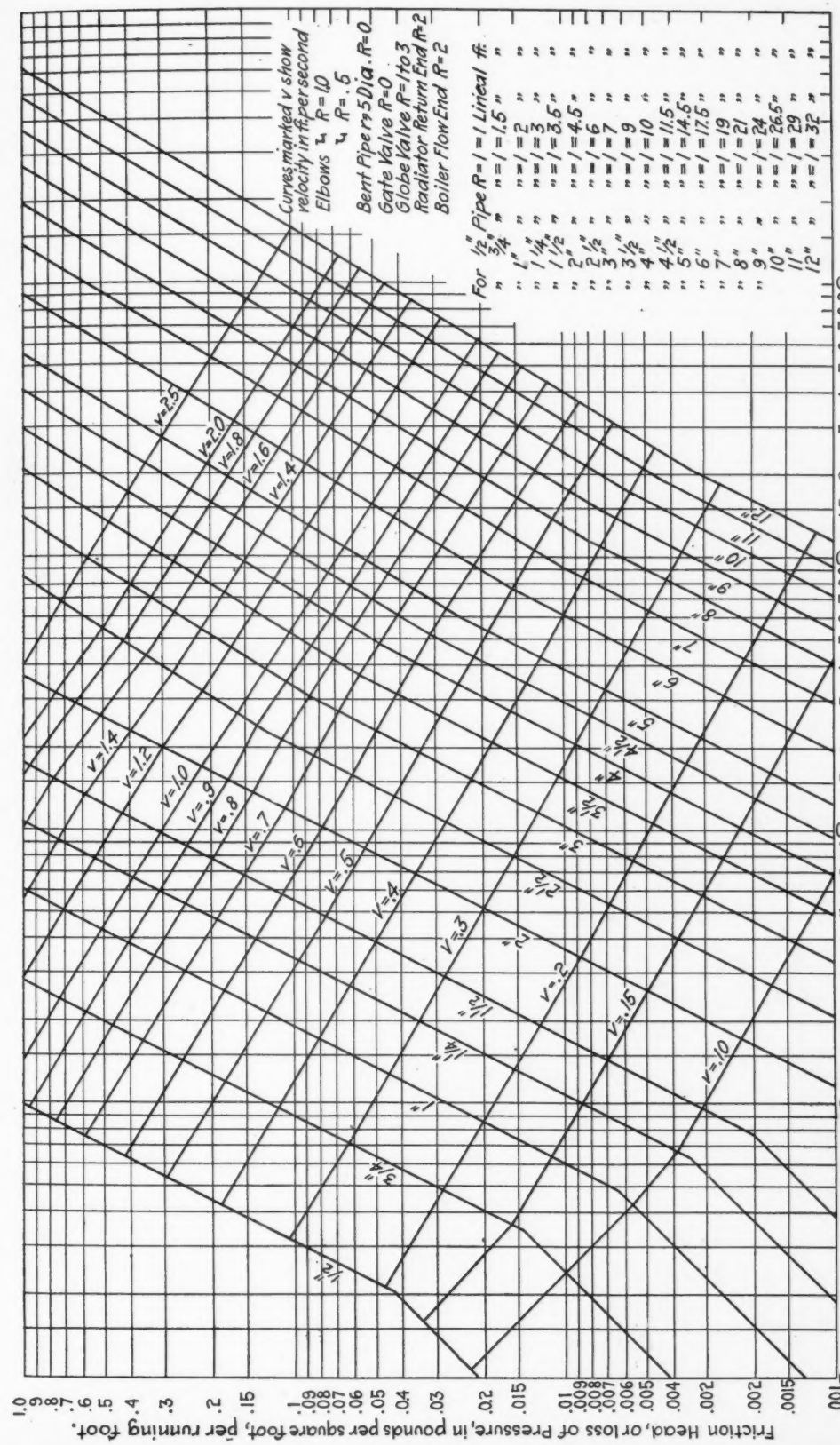
Curves marked v show velocity in ft per second
Elbows R=1.0
R=.5
Bent Pipe r=5 Dia. R=0
Gate Valve R=0
Globe Valve R=1 to 3
Radiator Return End R=2
Boiler Flow End R=2
For 1/2" Pipe R=1 = 1 Lineal ft.
3/4" " " = 1 = 1.5 " "
1" " " = 1 = 2 " "
1 1/4" " " = 1 = 3 " "
1 1/2" " " = 1 = 3.5 " "
2" " " = 1 = 4.5 " "
2 1/2" " " = 1 = 6 " "
3" " " = 1 = 7 " "
3 1/2" " " = 1 = 9 " "
4" " " = 1 = 10 " "
4 1/2" " " = 1 = 11.5 " "
5" " " = 1 = 14.5 " "
6" " " = 1 = 17.5 " "
7" " " = 1 = 19 " "
8" " " = 1 = 21 " "
9" " " = 1 = 24 " "
10" " " = 1 = 26.5 " "
11" " " = 1 = 29 " "
12" " " = 1 = 32 " "
Friction Head, or loss of Pressure, in pounds per square foot, per running foot.
B. t. u. per Hour

FIG. 3.—CHART FOR FIGURING PIPE SIZES FOR GRAVITY HOT WATER HEATING SYSTEMS.

1,000. The greatest amount of B. T. U. is placed at 10,000,000. The limits of friction head are taken at from 0.001 lbs. per sq. ft. and 0.5 lbs per square foot, both per running foot. In gravity hot water heating practice, one would hardly have to deal with a friction head less than 1/1,000 lbs. per square foot, or more than 0.5 lbs. per square foot per running foot.

As an illustration showing how the curve was plotted, let us take a piece of straight pipe 1.5 in. in diameter, 1 ft. long. Figuring from the formulas:

$$v_l = \frac{0.158}{d}$$

$$v_u = \frac{1.382}{\sqrt{d}}$$

$$P = 0.05643 \times \frac{lv}{d^2}$$

$$P = \frac{lv^2}{d} \times 0.893 \times \left(0.33 + \frac{0.226}{\sqrt{d}}\right)$$

$$P = \frac{lv^2}{d} \times 0.893 \times \left(0.12 + \frac{0.226}{\sqrt{d}} + \frac{0.228}{v\sqrt{d}}\right)$$

$$v = \frac{\text{B. T. U. per hour}}{43{,}096 \times d^2}$$

At l = 1 ft. and d = 1.5 in. these calculations will become

(2) v_l = 0.105 ft. per second.

(3) v_u = 1.225 ft. per second.

(4) P lbs. per square foot per running foot = 0.02505 × v.

(5) P lbs. per square foot per running foot = 0.3063 × v^2.

(6) P lbs. per square foot per running foot = $0.595 \times v^2 \times \left(0.304 + \frac{0.235}{v}\right)$.

(7) v ft. per second = $\frac{\text{B. T. U. per hour}}{96{,}966}$

Formulas (4) and (5) at critical velocities will give us:

P_l = 0.025 × 0.105 = 0.0026 lbs. per square foot per running foot.

P_u = 0.31 × 0.122^2 = 0.46 lbs. per square foot per running foot.

P_l and P_u show us that for friction heads up to 0.0026 lbs. per square foot we shall have to use formula (4). Between 0.0026 lbs. per square foot and 0.46 lbs. per square foot we shall have to use formula (5). Where the friction head is higher than 0.46 lbs. per square foot, formula (6) will have to be used. Then we can write a series of equations as follows:

Formula (4)—

0.001 = 0.25 × v; v = 0.04. B. T. U. per hour = v × 96,966 = 3,878.

0.002 = 0.025 × v; v = 0.08. B. T. U. per hour = 0.08 × 96,966 = 7,757.

Formula (5)—

0.004 = 0.306 × v^2; v = 0.114. B. T. U. per hour = 0.114 × 96,966 = 11,050.

0.010 = 0.306 × v^2; v = 1.8. B. T. U. per hour = 0.18 × 96,966 =17,453.

0.40 = 0.306 × v^2; v = 1.142. B. T. U. per hour = 1.142 × 96,966 =110,734.

On the chart the B. T. U. per hour are shown on the abscissa axis and friction head, or loss of pressure in pounds per square foot per running foot, on the ordinate axis. Having solved the above series of equations you get loss of pressure or friction head, on one side, and corresponding B. T. U. per hour transmitted by the pipe on the other. Now it is easy to plot the curve. Only two points are necessary to plot the part of the curve corresponding to the same formula, so that part will be a straight line. Wherever the third point was determined from the same formula, it was to check first two points. In the above example it has seemed unnecessary to use formula (6) as the loss of pressure corresponding to the upper critical velocity is very near the chosen limit of friction head. Should, however, formula (6) be used in this or any other case, the pro-

cedure will remain the same as stated above.

How to Use the Chart.

So far we have dealt exclusively with straight pipe, bends and other local resistances not having been considered. It has been customary to express the loss of pressure due to local resistances as

$$P = R \times \frac{v^2}{2g} \text{ ft. of water column, } v$$

being velocity of flow in feet per second .....(8)

Here R has usually been taken equal to:

0.5 in case of a short bend.
1.0 in case of a sharp bend.
0 in case of a long bend (radius > 5d).
0 in case of a gate valve.
1 to 3 in case of a glove valve.
2 in case of the return end of a radiator (vena contracta).
2 in case of the flow end of a boiler (vena contracta).

If a local resistance should contain R = 1, how many lineal (straight) feet of pipe would that be equivalent to? To answer this, we need only apply formula (5) which applies mostly to gravity hot water heating, writing an equation:

$$\frac{lv^2}{d} \times 0.1757 \times \left(0.33 + \frac{0.226}{\sqrt{d}}\right) = R \times 12 \times \frac{v^2}{g}$$

For R = 1, we get

$$l = \frac{12 \times d}{64.4 \times 0.1757 \times \left(0.33 + \frac{0.226}{\sqrt{d}}\right)}$$

For example:

$$d = 1 \text{ in.} \quad l = \frac{12}{64.4 \times 0.1757 \times 0.556} = 1.9 \text{ or } 2 \text{ feet}$$

$$d = 4 \text{ in.} \quad l = \frac{12 \times 4}{64.4 \times 0.1757 \times 0.443} = 9.6 \text{ or } 10 \text{ feet.}$$

and so forth.

Thus the resistance of a 4-in. globe valve can be taken as great as that of R × 10 lin. ft. of straight 4-in. pipe; that is, 2 × 10 = 20 ft., if R = 2. The loss of pressure due to a 1-in. short bend will be as great as that of R × 2 = 0.5 × 2 = 1 lin. ft. of straight 1-in. pipe, and the loss of pressure due to vena contracta at the flow end of the boiler, if its flow opening and the attached pipe is, say, 6 in., will be as great as that of 2 × 17.5 = 35 ft. of straight pipe 6 in. in diameter; that is, in the latter case, vena contracta as to resistance is equivalent to 35 ft. of straight pipe. (For other R's see the accompanying chart.)

A Typical Example.

Now let us see how to use the chart in an example. Assume the flow tem-

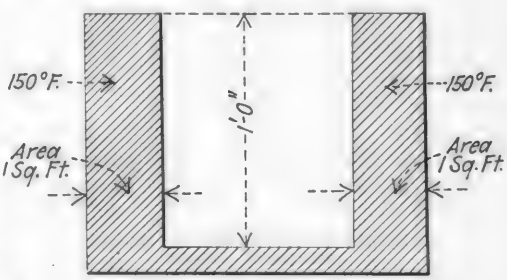

FIG. 1.—SKETCH OF EXAMPLE SHOWING USE OF CHART.

perature to be 180° F., and the return 150° F. Imagine two columns of water connected at the bottom as per sketch (Fig. 1). The right-hand column weighs 61.201 lbs., the left-hand column weighs 60.548 lbs., the difference being 0.653 lbs. Apparently, there exists a pull from the right-hand column to the left-hand column, due to that temperature difference, with a force of 0.653 lbs. per square foot. Should the column be 50 ft. high, the pulling force would be as great as 50 × 0.653 = 32.65 lbs. per square foot. This pulling force is usually called the "available pressure head."

On the sketch of a hot water heating system (Fig. 2) the radiator farthest away and at the lowest point is fIf'. The problem is to figure out the piping so that water will surely circulate. The center of this radiator is 5 ft. above the center of the boiler, consequently the pulling force will be equal to 5 × 0.653 = 3.265 lbs. per square foot. This pulling

force must overcome the friction of piping of the whole circuit on which this radiator operates. The total length of this circuit is 285 ft., elbows, valves, etc., not considered.

Experience shows that from 50% to 100% should be allowed to equalize local resistances to straight pipes. Let us take 75%.

tributed equally along the total equivalent length of the circuit; that is, the loss of pressure per square foot per running foot can be taken as equal to 3.265 ÷ 500 = 0.0065 lbs.

Referring to the chart (Fig. 3) find on the ordinate axis 0.0065 lbs. and follow the horizontal line, corresponding to 0.0065, up to the ordinate corresponding

PARTS OF PIPING			
ba=30' Long 1 Globe Valve 4 short Elbows	fg=10' 2-V-Els	mVm'=10' 2 V 10 Els
a'b=30' " 1 " " 4 " "	f'g'=10' " - " - "	mVm'=50' " 1 " 10 "
ac=20' " 1 " " 1 " "	gIIg'=10' " 1 " 8 "	an =10' " 1 " 2 "
a'c'=20' " 1 " " 1 " "	gh =10' " - " - "	a'n' =10' " 1 " 2 "
cd=40' " - " " 1 " "	g'h'=10' " - " - "	no =20' " - " 3 "
c'd'=40' " - " " 1 " "	hIIIh'=10' " 1 " 8 "	n'o' =20' " - " 3 "
de=30' " - " " 2 " "	ci=10' " 1 " 1 "	oVIIo'=10' " 1 " 8 "
d'e'=30' " - " " 2 " "	c'i'=10' " 1 " 1 "	oVIIIo'=25' " 1 " 10 "
ef=10' " - " " 2 " "	iVIi=40' " 1 " 10 "	
e'f'=15' " 1 " " 2 " "	im=20' " - " 3 "	
fIf'=10' " 1 " " 8 " "	i'm'=20' " - " 3 "	

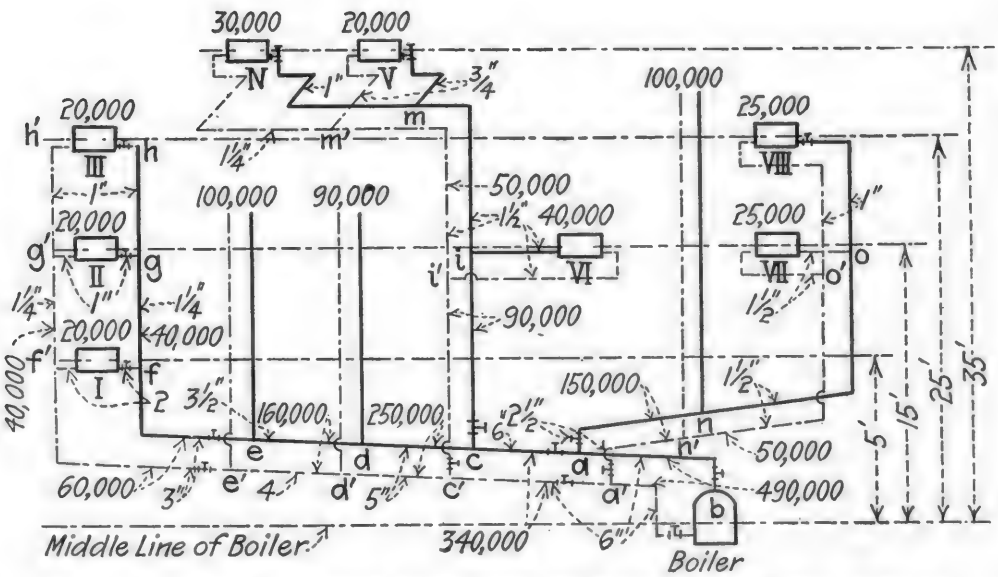

FIG. 2.—SKETCH OF HOT WATER HEATING SYSTEM USED IN EXAMPLE.

The total equivalent of the circuit in question will then be 285 × 1.75 = 500 ft. The total friction head, which must be balanced by the available pulling force of 3.265 lbs. per square foot, can be dis-

to 20,000 B. T. U. The tip of the finger will lie between 1½-in. and 2-in. pipes. You will therefore take the 2-in. pipe for the radiator connection. In a similar manner it will be found that:

fe, f'e', each 60,000 B.T.U. = 3-in. pipes.
ed, e'd', each 160,000 B.T.U. = 4-in. pipes.
dc, d'c', each 250,000 B.T.U. = 5-in. pipes.
ca, c'a', each 340,000 B.T.U. = 6-in. pipes.
ab, a'b', each 490,000 B.T.U. = 6-in. pipes.

Having thus obtained the sizes of the mains, it is possible to figure out the exact amount of friction head, or loss of pressure, at the dimensions found, in order to see how correct the dimensions are. It may appear that some sizes are too big and could be made smaller. Variation in this respect can be made so long as the total friction head is kept equal to the available pressure head of 3.265 lbs. per square foot.

The procedure will be as follows:

Having the B.T.U. and size pipe for a part of the piping, find on the chart the corresponding friction head, or loss of pressure, in pounds per square foot per running foot. Then multiply this by the total equivalent length of that part of the piping. Add all the products thus obtained for all parts of the circuit in consideration and the sum will be the total loss of pressure to be balanced by the available pressure head.

Let us take for globe valves R = 2, and, for elbows, R = 0.5. We will assume that all valves are of the globe type. Then from the chart we get:

ab = 6 in. = 490,000 B.T.U.; p = 0.006 × [30 + (2 + 2 + 4 + ½) × 17.5] = 0.006 × 135 = 0.810 lbs. per square foot.

Proceeding in a similar manner for the other portions of the piping, we get a total friction head on the circuit of Radiator fIf' of 3.041 lbs. per square foot, which is less than the balancing pulling force of 3.265 lbs. One could let it go at that, but if greater accuracy were desired, we could choke the circuit somewhere on the line, making a part of it smaller. Let us make, for instance, pipe ed 3½ ins. in diameter instead of 4 ins. as suggested. In doing this, we increase the friction in this part of the circuit from 0.216 lbs. to 0.01 × [30 + 2 + ½ +9] = 0.01 × 39 = 0.39 lbs. and the total friction head of the circuit will become 3.041 − 0.216 + 0.390 = 3.224 lbs. against the available pressure head of 3.265 lbs. Piping thus figured can be considered accurate enough and a proper circulation is assured.

Proceeding to the next radiator directly above (gIIg') the vertical distance from its center to the center of the boiler is 15 ft. The pressure head is, therefore, 15 × 0.653 = 9.8 lbs. per square foot. This should be expended along the total length of the circuit from the boiler and back again. However, according to the preceding calculations, the mains from the boiler up to the points f and f' require 3.224 − 0.138 = 3.086 lbs. per square foot, consequently for the part fgIIg'f', there remains 9.8 − 3.086 = 6.714 lbs. per square foot, which should be equally distributed along this part. Its length amounts to 30 ft. Allowing 50% for ells and valves, we get a total equivalent length 30 × 1.5 = 45 ft., which gives us a loss of pressure per running foot of 6.714 ÷ 45 = 0.15 lbs. per square foot.

From the chart we get:

fg = 40,000 B.T.U = 1¼-in.; p = 0.135 × 10 = ... 1.35 lbs. per sq. ft.

f'g' = 40,000 B.T.U. = 1-in.; p = 0.435 × 10 = ... 4.35 lbs. per sq. ft.

gg' = 20,000 B.T.U. = 1-in.; p = 0.11 × [10 + (2 + 2 + 8 + ½) × 2] = 0.11 × 26 = ... 2.86 lbs. per sq. ft.

The sum P = ... 8.56 lbs. per sq. ft.

We see that the loss of pressure here is greater than the available head, which must not be. Taking the next dimension of the pipe f'g', we get f'g' = 40,000 B.T.U. = 1¼-in.; p = 0.135 × 10 = 1.35 lbs. per square foot, and the total loss of pressure will be 1.35 + 1.35 + 2.86 = 5.56 lbs., against the available pressure head of 6.714 lbs. Evidently we will have to let it go at that. But to avoid too rapid a circulation, we can put in an adjusting (shield) valve on the return end of the radiator.

The next radiator is hIIIh′. The vertical distance from the center of this radiator to the center of the boiler is 25 ft., and the available pressure head = 25 × 0.653 = 16.3 lbs. per square foot, which must be expended equally along the circuit from the boiler and back again. But according to the foregoing calculation, the friction head from the boiler along the piping up to the points g and g′ amounts to 3.086 + 2.70 = 5.786 lbs. per square foot. For the part ghIIIg′h′ there remains, consequently, 16.3 — 5.786 lbs. = 10.514 lbs. per square foot, to be distributed along the actual length of 30 ft., or 30 × 1.5 = 45 ft. equivalent. That gives 10.514 ÷ 45 = 0.23 lbs. per square foot per running foot.

From the chart we get either:

1. ghIII = 20,000 B.T.U. = 1 in.; p = 0.1075 × [10 + 5 + (2 + 4 × ½) × 2 = 0.1075 × 23 = 2.48 lbs. per square foot. IIIh′ = 20,000 B.T.U. = ¾-in.; p = 0.48 × [5 + (2 + 4 × ½) 1.5] = 0.48 × 11 = 5.28 lbs. per square foot. h′g′ = 20,000 B.T.U. = 1-in.; p = 0.1075 × 10 = 1.08 lbs. per square foot. The sum P = 8.84 lbs. per square foot.

2. ghIIIh′g′ = 20,000 B.T.U. = 1-in.; p = 0.1075 × [30 + (2 + 2 + 8 × ½] = 0.1075 × 46 = 4.95 lbs. per square foot, or,

3. gh = 20,000 B.T.U. = 1-in.; p = 0.1075 × 10 = 1.08 lbs. per square foot. hIIIh′ = 20,000 B.T.U. = ¾-in.; p = 0.48 × [10 + (2 + 2 + 8 × ½) × 1.5] = 0.48 × 22 = 10.55 lbs. per square foot. h′g′ = 20,000 B.T.U. = 1-in.; p = 0.1075 × 10 = 1.08 lbs. per square foot. The sum P = 12.71 lbs. per square foot.

Here only cases 1 and 2 can be taken into consideration, because in the third case, the loss of pressure exceeds the available pressure head. In cases 1 or 2, a shield valve must be employed. It seems that case 2 ought to be finally accepted.

The loss of pressure for the other portions of the system may be figured in the same manner as for the circuits here worked out.

The method described in the foregoing of figuring a gravity hot water heating system is one which is based on correct, scientific principles and is as exact as it is possible to make it. One can figure a layout as close as one's time permits. The procedure may appear to require a large amount of time, but after one has figured a job conscientiously, one will easily see that the method is much more simple. The main requirement is that the underlying principles should be well understood.

It might be added that anyone interested in knowing what the velocities are at which water flows in gravity hot water heating apparatus, can obtain same from the curves on the chart marked "v".

Ventilation of Gymnasiums

DETAILED RESULTS AT SPRINGFIELD (MASS.) VENTILATION PLANT.

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(Read at the Fourth International Congress on School Hygiene, Buffalo, N. Y., August 25-30, 1913.)

EDITOR'S NOTE.—So many references have been made in these columns and elsewhere to the astonishing results achieved with recirculated air in the gymnasium of the International Y. M. C. A. College, at Springfield, Mass., that more than ordinary interest attaches to the detailed account of the experiments, which is here presented, substantially in full.

Most of the men here assembled could do their work in temperatures much below 60° F. The Chicago Commission on Ventilation in its 1911 report recommend 60° to 68° F. as the proper temperature for the schoolroom. The commission designates as a cold room, one with a temperature of 55° to 60° F. Under these conditions of temperature (60° to 68° F.) it is impossible to keep the nor-

mal humidity of outside air during cold weather up to the normal amount without adding moisture artificially. With atmospheric pressure at approximately 30 ins. and the temperature at 0° F. a cubic foot would hold 0.481 grains of moisture; at 32° F. it would held 2.113 grains of moisture; at 60° F. it would hold 5.745 grains, and at 70° F. it would hold 7.98 grains.

Vapor or space at 0° F. and 50% relative humidity would contain approximately 0.24 grains of moisture per cubic foot. This vapor on being heated to 70° F. would still contain its absolute humidity of 0.24 grains of moisture per cubic foot, but its relative humidity would drop from 50% to 3% except as the air passages and skin of pupils became water jugs which were continually emptying water from the bodies of the pupils into the air of the room. Air at 32° F. and 50% relative humidity would contain approximately 1.056 grains of moisture per cubic foot. This air on being heated to 70° F. would then have a relative humidity of 13% unless moisture was added from the pupils, walls or fixtures in the rooms. I have not found any figures showing the effect on room humidity of varying moisture conditions in different types of walls, *e. g.*, concrete, brick, etc.

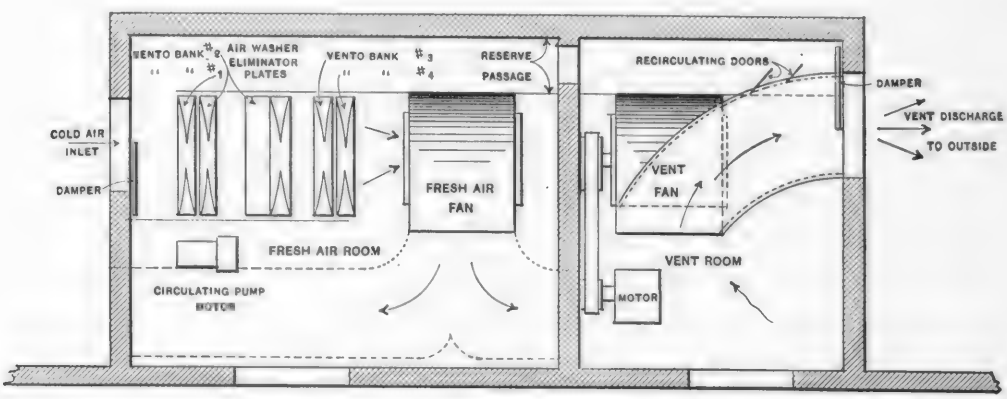
The textbooks of physiology assert that all expired air is warmed nearly to body temperature and is nearly saturated with water vapor at about body temperature. If this is true under all outdoor and indoor conditions, the amount of moisture needed to saturate each respiratory column is the same whether the air breathed in be cold air at 10° F. or this same air warmed up to 70° F. without the artificial addition of moisture and then breathed. Before much more is said we need to know (1) whether expired air is always saturated; (2) whether it always approaches body temperature; (3) whether dry air is harmful to bodily tissues or functions.

The school room relative humidity does not ordinarily rise above 25%. More often its range is from 16% to 23%. (Tuttle.)

Description of the Springfield Ventilation Plant.

I will not attempt more than a general description of the plant, as a careful description has already been given by Professor Affleck in a preliminary report. The college aimed in building its two gymnasiums to make them halls of health in fact as well as in name. The architect and engineer co-operated with the owners in considering the building as a health factory. In building factories the use of the building is the first consideration. This is not always true with public buildings. Architectural beauty is often put before utility or health.

In the general instructions of the committee to the architect and engineer the owners insisted upon thorough ventila-



ARRANGEMENT OF VENTILATING PLANT, INTERNATIONAL Y. M. C. A. COLLEGE GYMNASIUM.

tion. Basing their idea of the needs of the individual upon Smith's statement concerning the production of CO_2 during active exercise (E. Smith found that a man at rest produced 161.6 C. C. of CO_2 per minute; walking two miles an hour, 569.3 C. C. of CO_2 per minute; walking three miles an hour, 851.2 C. C. of CO_2 per minute; during tread mill work, 1,-581.9 C. C. of CO_2 per minute) they asked the architect and engineer to build a ventilation plant which would handle 300 cu. ft. per minute per individual. The owners were told that this was ten times the present requirements for school buildings, and that it would be necessary to nail the pupils in their places to prevent their being sucked into the ventilating plant, that the scheme was prohibitive from the expense standpoint. Dartmouth College, they said, had just put in a ventilating plant which furnished double the amount required bv school room law, or 60 cu. ft. per minute per individual.

The ventilating plant according to anemometer tests made by the R. D. Kimball Company April 8 and 9, 1913, introduced 21,430 cu. ft. of air per minute into the West Gymnasium, or 306 cu. ft. per minute per individual with a class of 70 men as a basis. The air motion was never uncomfortable for gymnasium classes. Double this amount of air, or 600 cu. ft. per minute per individual, was moved without uncomfortable sensations for a class of 50 by turning all the air from the East Gymnasium into the West Gymnasium.

An interesting experiment was tried on a Public Recreation Congress assembled in the West Gymnasium in April, 1912. With all the doors and windows closed 30,000 cu. ft. of air was introduced each minute at 63° F. The bald headed people vainly tried to find the open window. A little later the air temperature was raised to 65° F. This gave apparent comfort even to the bald headed members of the audience.

The expense item at first could only be answered by saying that good things come high. After the building was practically complete the author suggested to the engineer connecting the plenum and exhaust rooms so the air could be recirculated in warming the building for early morning use in cold weather. So far as I know this is the first time air has been washed, treated and returned regularly for use during the active exercise period. The significance of this innovation is shown by the studies of Whipple and Kimball. The idea of recirculation of the air during the active use of the building came as a result of committee discussions, and an examination of the work particularly of Flugge and Paul.

Fortunately, the ventilation plant which was arranged to keep down the CO_2 content in the gymnasium by furnishing over 300 cu. ft. of air per minute per individual could also control temperature, air motion, moisture content, odors, bacteria and dust. It was found that the recirculation scheme which had already been arranged for economy in early morning heating could also be used during the periods when the gymnasium was in active use.

Striking Features of the Plant.

1. Its flexibility.

(a) The air entering the rooms may be, aside from leakage

1. Entirely outside air heated, washed and humidified or not, as desired.

2. Entirely air drawn from the room heated, washed and humidified or not as desired (recirculated air).

3. Any percentage combination of outside and recirculated air.

(b) The air leaving the room may be, aside from leakage,

1. Exhausted from the rooms directly outdoors.

2. Exhausted from the rooms into the plenum fan room for return back to the gymnasium. This recirculated air may be heated, washed and humidified or not as desired.

3. Any percentage combination of this air may be delivered out doors or returned to the rooms through the plenum fan room where it may be heated, washed or humidified or not as desired.

2. The large volume of air supplied per minute per person.

An estimate based on the classes for 1912-13 in the West Gymnasium gives for the junior class of fifty men 400 cu. ft. per minute per individual, freshmen class of ninety men 222 cu. ft. per minute per individual.

3. Appreciable air movement.

The rate of air movement at the inlets to the room is 350 ft. per minute and at the outlets 400 ft. per minute as tested by the R. D. Kimball Company.

4. The intake of large volumes of air at a low temperature, 60-65° F., rather than a small volume of air at a high temperature, 100-140° F.

5. The low room temperature, 60° F., prevailing during the exercise periods from 1:30 to 6 P. M.

6. The moderately high relative humidity for indoor winter conditions, 46% to 50% (Knapp, p. 54) as compared with averages in nine school rooms ranging from 16% to 23% (Tuttle, p. 35).

7. The removal of dust, bacteria and odors.

Prof. Whipple in his conclusions states that "Air washing makes use of a process very efficient in Nature, and is capable of removing from air a large absorption of dust, bacteria and solid particles, and further that there are absorbed nitrous and ammoniacal vapors and organic compounds of uncertain composition which impart odors and unpleasant qualities to the air." He further says that "Recirculation as practised at this institution has provided a plentiful supply of air with no apparent sacrifice of wholesome properties. It is a safer source of supply than outside unwashed air and has further effected a decided economy in the consumption of fuel for heating purposes."

8. The possibility of using recirculated air, or canned air, as it has been called, without any dangerous increase in the CO_2 air content and without any personal discomfort.

9. The inexpensiveness of recirculation as compared with pumping through the building outdoor cold air continuously.

The total cost of recirculation with the external temperature at 0° F. was estimated by the R. D. Kimball Company as 52 cents per hour as compared with 107 cents per hour for using outside air.

The outdoor dry bulb temperature range from January 26 to March 20, according to Samson, was 18° to 56° F., and, according to Knapp, from January 16 to April 10, 16° to 63° F.

During this period the indoor dry bulb temperature range was 74° to 70° F. (Samson) and 51° to 72° F. (Knapp). The outdoor relative humidity range was 29 to 100% (Samson) and 43 to 100% (Knapp).

The indoor relative humidity range without humidification was 29 to 56% (Samson) and 17 to 49% (Knapp). Analysis of Mr. Knapp's figures showed an M. F. V. with fresh air direct of 17 to 49%; with no artificial ventilation (doors and windows closed) of 19 to 35%; with air recirculated and mixed with fresh air of 33 to 39%.

The indoor relative humidity range with humidification was 36 to 90% (Samson) and 23 to 64% (Knapp).

Again, an analysis of Mr. Knapp's indoor humidities with humidification shows, with air recirculating, 32 to 63%; with fresh air direct, 25 to 53%; with air recirculated and mixed with outdoor air 50 to 64%.

A still further analysis of Knapp's data shows that 14 out of 18 observations without humidification had a relative humidity below 40%, while 62 out of 93 observations with humidification had a relative humidity of 40% or above. Four out of five observations with the outside air below freezing, without room humidification, showed a relative humidity below 22%, while 28 out of 33 observations under similar temperature conditions, with humidification, showed a relative humidity above 40%.

The men preferred a temperature of about 60° F. and a relative humidity of from 46% to 50%. A comparison of the freshman and junior classes shows no class variation. Both the freshmen and junior medium temperature choices were 60°, the freshman median relative humidity value was 46.5%, the juniors 47%.

Outside vs. recirculated air choice, both humidified.

Air Temperature, Deg. F.			
Recirculation			
Min.	Max.	Range	Mean
53	67	14	60.3
Outside air			
54.5	63.5	7	58.8
Humidity, Per Cent.			
Recirculation			
36	68	32	53.1
Outside air			
27	53	26	36

You will note that the outside air relative humidities are lower than the recirculated air. This is due to the fact that

the humidifier was set for a lower humidity when the observation was taken. In spite of this difference in humidity the men were unable to differentiate between outside air and recirculated air. The outside air forced into the building without washing or humidifying had a median temperature of 60.5° and a relative humidity of 30%.

Effect of Recirculation on the Temperature and Humidity with the Air Washer Running.

The question has been asked whether the temperature and humidity rise with continued recirculation. Twenty observations were taken between January 16 and February 19, 1913, in the exhaust duct where the air would be thoroughly mixed. The first readings were taken after the fans and washer had been running one hour and 45 minutes. The class session began at the time of starting the fans and continued throughout the tests. The second reading was taken on the average two hours after the first one. The temperature fell in 14 out of 20 observations from 5° to 2° between the first and the second test. It remained the same in three observations and rose in three. The variability in any case was never more than 2° F. Both the relative and absolute humidity increase slightly but not more than 2% of relative humidity, or 0.1 of a grain per cubic foot of absolute increase.

REFRIGERATION OF AIR.

Recirculation has affected real economy in operation. Body heat from the men has required us to turn off all direct and indirect radiation from the gymnasiums and fan room during the periods of exercise. As a matter of fact we have had to run the air through the air washer water at about 50°-54° F. to keep the room temperature down.

At the discussion of Affleck's report on the first year's work by Samson at the Montreal Convention of the American Physical Education Association in 1912, Prof. T. A. Starkey of McGill University raised a question regarding the accuracy of the government sling psychrometer for low humidities. Geer in his study last year found the error of the instrument not to exceed 2% for ordinary room temperatures when compared with chemical hygrometry. For temperatures around the freezing point he found the instrument inaccurate, first, because of the long time of whirling needed to reach the low temperature point with the wet bulb; second, because a small error in reading, e. g. 0.5 of a degree would change the relative humidity 5% or 6%. At room temperature a 0.5° error would only change the reading about 2%. He compared the results by chemical absorption of a known quantity of air with those of the sling psychrometer in a closed room where temperature could be accurately controlled. He used the dehydrating power of concentrated sulphuric acid as the method of removing the moisture from the air. This moisture was then weighed and the relative humidity computed and compared with the records of the sling psychrometer taken at the same time.

We found the college plant at Springfield during recirculation of air could control within normal limits temperature, humidity, air movement, bacteria, dust and odors. The actual determination of the CO_2 content in the gymnasium while recirculating the same air during the active exercise of large groups of men seemed the next step. It seemed necessary to determine how much the CO_2 would increase in the room with the large output from the men during active exercise, and whether it might not even increase above the high limit of 150 parts in 10,000 set by Flugge and others. The determination of CO_2 during these experiments was made by Peterson and Palmquist apparatus as modified by Dr. Rodgers of the New York State Labor Department.

We found by experimentation the following facts. These data are taken from Horne's thesis for the current year 1912-13. The men were doing vigorous exercise, calisthenics, dancing and apparatus exercises, for 1½ hours. The observations were taken after the men had been working for one hour.

These tests show that the CO_2 content in the gymnasium air before use is practically that of outdoor air. The fans were not running during these tests.

TABLE 1.—CO_2 TESTS BEFORE THE USE OF THE GYMNASIUM.

Date, 1913	Time	CO_2 per 10,000 of Air. Track. Av. CO_2	Track. No. Tests	Floor. Av. CO_2	Floor. No. Tests	Remarks.
Jan. 21	12.00— 1.00	4.0	3	3.8	3	Tests on floor were made about 3 ft. above the floor.
Jan. 22	11.00—12.00	3.8	2	4.0	3	
Jan. 31	11.00—12.00	4.0	3	3.5	3	
Feb. 3	11.00—12.00	3.4	2	4.2	2	
Feb. 4	11.00—12.00	3.5	2	3.5	2	
Feb. 18	11.30—12.00	3.5	2	3.5	2	
Average		3.7	.	3.75		

DIRECT VENTILATION.

The air was drawn from out-doors and forced directly through the ventilation system to the rooms. The plenum exhaust fans handled enough air to change the entire amount in the room (180,000 cu. ft.) every nine minutes.

CO_2 content ordinarily between 7 and 8 parts in 10,000.

RECIRCULATION TESTS.

In these tests the air was returned from the gymnasium to the air washer where it was washed and partly refrigerated by passing through vat water at 50-

TABLE 2.—CO_2 TESTS WITH DIRECT VENTILATION.

Date, 1913	Time	CO_2 per 10,000 of Air. Track Av. CO_2	Track No. Tests	Floor Av. CO_2	Floor No. Tests	No. Men Exer.	Remarks
Jan. 31	4.15—4.30	6.5	2	7.0	2	30	
Feb. 3	4.20—4.30	7.0	2	6.0	2	35	
Feb. 20	4.55—5.25	8.0	4	8.0	4	40	
Feb. 21	4.25—4.55	7.5	2	7.6	3	34	
Feb. 28	4.50—5.10	7.8	2	8.0	2	30	
Mar. 3	5.15—5.40	6.9	2	6.8	2	25	
Mar. 5	4.40—5.00	6.5	2	6.5	2	35	*Exams.
Mar. 4	2.45—4.45	7.0	3	6.7	3	35	
Mar. 7	4.00—4.30	5.6	2	5.9	2	35	Tests taken on floor were taken at 5 ft. 5 ins.
Mar. 10	5.30—5.40	8.2	2	8.0	2	35	
Apr. 7	4.50—5.20	6.9	2	7.0	2	30	
Apr. 8	5.00—5.15	7.0	2	7.1			
Average		7.21	.	7.16			

*This test is not included in average.

The CO_2 content of the gymnasium air during exercise is nearly double that of the gymnasium air before the gymnasium has been used. The increase on the breathing level (5 ft. 5 in.) was from 3.75 to 7.16 parts in 10,000. On the gallery level the increase was from 3.7 to 7.21. An examination of the table shows that only once did the CO_2 rise above 8 parts in 10,000, and then only up to 8.2 parts in 10,000. The tests showed the 54° F. This cooling was necessary to keep the relative humidity from increasing.

As the table shows, there is a fairly constant variation between 7.5 parts and 9 parts in 10,000. The gallery level shows an average of 9.33 parts in 10,000 as compared with 8.33 parts on the breathing level. I have no explanation for the gallery level being regularly higher. These figures are not above the safety

TABLE 3.—CO_2 TESTS WITH RECIRCULATED AIR.

Date, 1913	Time	CO_2 Per 10,000 of Air. Gallery level Av. CO_2	Gallery level No. Tests	Breathing level Av. CO_2	Breathing level No. Tests	No. Men Exer.	Remarks
Jan. 20	4.30—6.00	10.0	2	8.0	2	39	
Jan. 21	4.00—4.45	8.0	3	8.3	3	33	
Jan. 22	4.30—5.15	7.5	2	7.9	4	35	
Jan. 25	3.20—5.00	13.0	2	9.6	5	36	
Jan. 29	4.55—5.00	8.5	2	7.5	2	34	*Fan not running.
Feb. 4	5.00—5.30	14.0	5	13.0	5	38	
Feb. 5	5.00—5.45	9.0	3	9.0	3	26	Tests taken on floor were taken at a height of 5 ft. 5 ins.
Feb. 6	2.15—3.55	11.5	2	8.5	2	70	
Feb. 7	4.25—4.50	10.0	2	9.0	2	27	
Feb. 10	4.55—5.35	6.0	2	6.5	2	25	
Feb. 13	4.40—4.55	8.0	2	7.0	2	26	
Feb. 18	3.55—4.05	8.5	2	7.5	2	35	
Feb. 18	2.25—3.10	7.6	3	8.2	2	30	
Feb. 19	4.35—5.05	8.7	2	8.0	2	28	
Average		9.33	.	8.33			

*This test is not included in average.

range on the old basis. Richards & Woodman state in their text "Air, Water and Food" (p. 26) that the CO_2 in school rooms should not rise above 8 or 9 parts in 10,000 and in lecture halls not above 9 to 11 parts.

WINDOW VENTILATION (FANS NOT RUNNING.)

All the windows, 56 in number with 415 sq. ft. of window surface, were open wide.

TABLE 4.—CO_2 TESTS WITH WINDOW VENTILATION.

Date, 1913	Time	CO_2 per 10,000 of Air. Av. CO_2	Track No. Tests	Track Av. CO_2	Floor No. Tests	No. Men Exer.	Remarks
Apr. 10	2.55—3.15	5.9	2	5.0	2	64	Strong breeze from the west.
Apr. 14	3.20—3.30	5.7	2	5.4	2	41	No wind.
Apr. 22	3.00—3.30	6.0	2	5.6	2	70	
Average		5.8		5.3			

This table shows the lowest CO_2 content of any of the exercise tests. These observations were unsatisfactory because of the warm outside air which allowed all the windows to be opened wide. It is hoped we can follow through tests next year under winter conditions which will show temperature, humidity, CO_2, odors, bacteria and dust conditions.

TABLE 5.—DIFFUSION TEST.
Feb. 18, 1913, West Gymnasium.

Hour	Place	CO_2	Remarks.
3.55	Track on east side	8.5	About 50 men on floor exercising since 2 P. M.
4.05	Center of floor 5 ft. from floor	7.5	As men were leaving floor just before ventilation plant shut down.
4.30	Same	6.5	Plant shut down at 4.05 and everyone was kept off floor.
5.00	Same	5.0	Same
5.30	Same	5.0	Same
6.00	Same	4.5	Same
6.30	Same	4.5	Same

This test was undertaken to find how long the CO_2 content would remain up to a high level. You will note that the CO_2 content sank down to 5 parts in 10,000 in less than an hour with all windows and doors closed. At the end of another hour and a half it had only sunk to 4.5 parts in 10,000. Apparently the diffusion is slower at the lower levels.

Conclusion.

1. Research workers should determine more definitely what changes take place in the air breathed in under varying air conditions of temperature and humidity. We need to know definitely whether air is always saturated and raised to body temperature on leaving the air passages.

2. We need to know whether dry air is harmful to bodily tissues or functions.

3. Considerable air movement in rooms unquestionably adds to the comfort of the occupants.

4. Drafts are not uncomfortable if the moving air is near room temperature. Ten times, 306 cu. ft. per minute per individual, the air required by school law was moved not only without discomfort but with increased comfort.

5. Expense can be materially reduced by using recirculated air even when the entire cost of ventilating machinery and its upkeep is included. Kimball's figures show the cost for recirculated air to be 52 cents, for direct ventilation of the same thoroughness 107 cents in the plant at Springfield.

6. The most comfortable air for gymnasium use has a dry bulb temperature of 60° F. and a relative humidity of 46% to 50%. Bald headed people suffer some discomfort with large air movement if the dry bulb temperature goes as low as 63° F. They seem comfortable at 65° F.

7. Proper room temperature, perceptible air movement, adequate moisture content, low bacteria and dust content, and the elimination of body odors are the essentials in healthy air.

8. Large CO_2 content in the air does not seem to render it unhealthy, at least so far as immediate discomfort or efficiency are concerned.

9. This series of studies shows that a recirculation plant is possible which will furnish air like the best outdoor air, *i. e.*, after it has been washed by rains, cheaper than by ordinary means of ventilation.

10. With recirculation the CO_2 content never rises above 14 parts in 10,000, and ordinarily it does not rise to above 9 parts in 10,000.

11. It is possible to control humidity, keeping it up near average outdoor conditions. This means raising the relative humidity roughly from 25% to 50%; or as some authors suggest, to 70%.

12. The government sling psychrometers are accurate within 2% for ordinary room temperatures.

Temperature Guarantee and the Heat Loss Factor

REASONS FOR CONSIDERING SUCH GUARANTEE UNDESIRABLE.

BY GEORGE CHASSER.

(From a Paper Read at the Autumn Meeting of the Institution of Heating and Ventilating Engineers, London, October 14, 1913.)

At the present time it is quite evident there is a growing tendency to include in all specifications for heating and ventilating installations, large and small, temperature and other clauses that must be guaranteed and fulfilled in an exacting manner before payment is made.

Before such binding conditions in all heating contracts become general, some form of standard practice should be adopted by our Institution, with which the engineer can safeguard himself against an over-reaching client who does not recognize the limitations of present-day heating practice. Owing to the want of some agreement, the engineer is compelled to include covering amounts for all the imaginary contingencies he can think of, to provide a margin to cover the unknown portion, or what may be called the "x" factor in his calculations.

This question of the doubtful and uncertain amount to be included brings forward the practical and commercial side of the problem. What chance in competition work have those who do carefully consider all contingencies and provide for them, against those who cut quantities and prices because they do not consider guarantees seriously, until they have to be fulfilled or payment is kept back?

To heat a building satisfactorily, under all the adverse conditions of weather that from observation over a number of years are expected to take place, an amount of heat must be provided that will cover the total heat losses. It is the diversity of opinion and want of uniformity as to what constitutes the necessary amount, that makes the temperature guarantee clause so unpopular.

I have often inquired from architects, engineers and others, why they are now so particular in requiring guarantees; the reply, in effect, being that some safeguard is necessary because many heating installations are more or less satisfactory with only moderate winter conditions, and at the time when frosty or bitter weather comes, with the outside temperature down to 30° F. or lower, the apparatus is inadequate to maintain an inside temperature of 60° F. or thereabouts, even under wasteful conditions of stoking. The probability is that many heating installations with high temperature radiation do just manage to maintain comfortable conditions inside, during moderate winter weather, but when the cold snap occurs 60° F. cannot be obtained inside, causing the apparatus to be condemned as being unsatisfactory at a time when it is most required. The owner, after spending money on a heating apparatus which does not give satisfaction, becomes annoyed, and gives the heating profession a bad name. It is conditions such as these that bring about the demand for temperature guarantees.

TOTAL HEAT LOSSES DIFFICULT TO CALCULATE.

The most difficult calculation to make, even more so than the determination of the radiating surface, is the one relating to the total heat losses through a building. However carefully the losses are calculated with the coefficients for glass, wall, ceiling, floors, doors and an imaginary air change, the margin to be added to cover the "x" factor is always an approximate quantity. The probability is that in competitive and hastily consid-

ered calculations no margin is added, either intentionally or because the importance of doing so is not recognized, and so the result is an apparatus that does not give satisfactory service.

CONDITIONS NOT USUALLY CONSIDERED.

Below are given some factors that are not usually considered in heat loss calculations, but which will serve to show how the quantity of heat transmitted is more for the wall and floor area, than is usually thought. For instance, the transmission through the wall area behind and in the vicinity of radiators and pipes is much more than other parts of the wall area. The same is also true, but in a lesser degree, of the floor area in the vicinity of the heating surface. Plans as a rule do not state whether the wall is to be wood panelled or have marble facings.

Wall furniture and library fittings also enter into the question. Then as to floors, nothing is usually known as to whether the covering will be carpet, hair rugs, or linoleum. These variations must affect materially the amount of heat transmitted. Other factors about which much difference of opinion exists are the probable inaccuracy of glass, wall and other coefficients, the quantity of air passing through chimneys and ventilators, air leakage through window sashes, doors and porous walls, constituting what is usually called the "change of air," and the additions to be added for aspect, corner rooms, wind exposure, exceptionally high rooms, interrupted service, humidity, etc.

It is obvious that in addition to the ordinary ones, the consideration of these additional heat loss factors, the number of which is not exhaustive, make the total heat loss calculations upon which the heating surface is based a difficult problem, and whatever may be the theoretical view of the matter, there is no alternative but to include some additions to cover them. As to how these conditions can be estimated for practical purposes should receive consideration.

At the present time there does not appear to be any general agreement as to which of these should be considered, and how or upon what basis they may be taken. Some agreement is necessary to bring about more uniformity of practice in obtaining the total heat loss factor which would make for more definite results. Expressions of opinion could be obtained from members as to how they regard these doubtful factors in their calculations; it may then be possible to formulate some suggestions towards standard practice.

If we calculate the heat losses on the 30° F. to 60° F. basis, take the co-efficients too rigidly and make no additions for the unknown heat loss factor, it will, I think, be seen to be one reason why it is often difficult to maintain 60° F. inside when 30° outside—without considering lower temperatures—under normal conditions of working. An apparatus should work on moderate firing intervals, even when the outside temperature is low.

It may be objected that this would require an unnecessary amount of radiation, which in moderate weather would not be needed, but the radiators could, of course, be cut off or the apparatus worked at low temperatures, which would be more satisfactory than not having the heating surface there when it is required.

GREATER TEMPERATURE DIFFERENCE SHOULD BE USED IN CALCULATIONS.

The remedy for the temperature clause guarantee is in the heating engineer's hands entirely. If clients will insist upon having guarantees they must pay for an installation that has a covering amount for extra power and to cover the expense of the test. In addition to the nearer approximation of the actual total heat loss which may result from a more uniform agreement in basing the unknown heat loss factor, a further covering margin could be met by taking a greater temperature difference between the inside and outside. The American, and most of the Continental engineers, as far as I can ascertain, base their calculations on the lowest outside temperature that was observed during a period of 20 to 25 years, the temperature differing according to the district. For example, the difference in New York is taken from 0° F. outside to 68° or 70° inside, and in some parts of Germany and Hungary (Budapest) —4° F. to 68° F. It appears that although these low

temperatures occur only very rarely, it is considered sound practice to provide for such a contingency, which leaves no doubt as to results during ordinary cold weather because of the considerable margin always available. It is known that under these conditions no objection is made to giving temperature guarantees.

Mr. Charles Knuth, of Budapest, Hungary, to whom this Institution is indebted for some of the most helpful and practical papers it has ever received, has informed us why heating engineers in his country are able to guarantee temperatures. I cannot do better than state his remarks in the criticism on Mr. Barker's paper on the "Conditions of Guarantees."

"Whilst agreeing entirely with his remarks regarding the uncertain, and not only uncertain but obviously incorrect coefficients, I have come to the opinion that on the basis of these coefficients of loss of heat we are able to guarantee the temperature to be obtained outside. It should be noted that all our heating plants are designed and calculated for a temperature of — 4° F.; this is our minimum, but the temperature does not last even one day in 25 years, while 5° F. is only reached on 7 days in 25 years; 14° F., 45 days in 25 years, and 23° F., 110 days in 25 years.

"If, therefore, the plants are really calculated to work efficiently when the outside temperature is —4° F., it is quite evident they will give satisfaction for the greater majority of days, even if the coefficients should be somewhat wrong. Supposing they are wrong, the fault will be evident all over the building, and not only in one room. It is then that the reserve which is calculated for every plant will come into play."

From the Continental and American practice it would appear that they have to provide for the coldest weather, and those who buy apparatus recognize that they have to pay accordingly. In this country (England) it is evident that if we only calculate for 30° to 60° F., we have no margin in the capacity of the apparatus to provide for colder weather, which may go down to 20° F. or even lower. Would it not be worth while to consider taking a lower outside basis? Information can be obtained from the meteorological reports for Great Britain and Ireland as to the prevailing outside temperature in a selected number of districts for the last 20 or 25 years and so obtain a basis to decide upon.

I would suggest that charts, similar to those shown in the American HEATING AND VENTILATING MAGAZINE giving the record of the weather for the winter months in selected districts in the British Isles be included in our bound report. They would be very useful for reference.

TEMPERATURE GUARANTEES UNDESIRABLE.

If the circumstances make a temperature guarantee undesirable, which is the attitude that should be adopted, some such recommendation as the following could be submitted to the client instead, as the recommendations adopted by the members of the Institution, instead of giving guarantees: "The engineer undertakes to install an apparatus properly proportioned in all its parts, in accordance with the standard practice recommended by the Institution of Heating and Ventilating Engineers, of which he is a member."

This recommendation, if submitted to the client, would in many instances serve instead of a binding guarantee, because of the knowledge that the work is being done on a standard practice recommended by the Institution.

TYPICAL SPECIFICATIONS.

A specification submitted for a low pressure hot water apparatus contained the following: "A temperature equivalent to 65° F., when the outside temperature is 25° F. in accordance with the following table is to be maintained four feet above floor level in the rooms when unoccupied and when the air is being changed three times in an hour. The following is the table of temperature to be obtained during the test of installations, if the external temperature is higher than 25° F.:

"Before the installation can be accepted the contractor will be required to maintain the difference in temperature specified above for 48 hours. The coal will be supplied for the test, and any excess beyond 10% of the consumption stated in the tender will be considered unsatisfactory, even though the temperature may be maintained. The heating

contractor is advised that the amount of general building work involved will be taken into account in judging the tenders."

TEMPERATURE, DEGREES F.

Outside.	Inside.	Outside.	Inside.
25	65	47	78
27	67	49	78
29	68	51	79
31	70	53	79
33	71	55	79
35	72	57	80
37	74	59	80
39	75	61	80
41	76	63	80
43	76	65	80
45	77	..	..

No pipe scheme was shown in the plans.

One point should be noticed. The government adopts the principle of a "corresponding difference of temperature," which it has probably found useful.

Another recent government inquiry for the provision of a new boiler for an existing apparatus contains the following: "The boiler to be of sufficient capacity to deal with about 2,000 lin. ft. of 4-in. C. I. warming pipes in a building of approximately 280,000 cu. ft. Contractors are to state the coal consumption for the particular boiler necessary to retain the water in flow pipes 10 ft. away from the boiler at a uniform temperature of 200° F. when the whole of the pipes are in full circulation. A test of 10 hours will be asked for before payment is made."

No plans or any suggestion as to the arrangement of the heating surface are given.

If it is true in the case of heating apparatus, as it is in other engineering matters, that the manufacturers are made to comply with the standards established by the various authorities like the Admiralty, War Office and municipal authorities who follow them, then, judging by these extracts from the specifications, the heating engineer should either ask for full plans of the heating scheme, with detailed specifications, and take no responsibility for the success of the apparatus, or be allowed to estimate according to the standard practice (if adopted) of the Institution.

Central Station Heating in the Smaller Cities.

With few exceptions, every small town and city has a commercial heating possibility that can be worked out in such a way as to prove advantageous and profitable.

In Indiana an ice company, fortunate in having adequate boiler equipment and experienced men, saw before them, literally and less than 1,000 ft. away, three public school buildings. At the request of the owners we analyzed the possible cost to manufacture and deliver the required live steam for heating these public buildings. The school authorities had their greatest problem in maintaining staid and dignified demeanor when the fact came to their knowledge that the schools could be served with steam generated away from the building, this steam to be available every day when desired, for every possible purpose, including swimming pool, cooking tables and live steam to drive the engine for the ventilating system. They found it made possible a substantial reduction in fire insurance rate and also the all important item of eliminating from every building every vestige of combustibles and possibilities of fire.

An inspired newspaper man said in writing up the annual commencement exercises that "the supper was served on the main floor." And really it is at all times clean enough.

The buildings heated by steam are as follows:

New High School Building, cubical contents heated	1,847,000
Old High School Building, cubical contents heated	258,000
Lincoln Ward School, cubical contents heated	205,000
Revenue for heating, 1910	$3,456
Revenue for heating, 1911	3,672
Revenue for heating, 1912	3,726

Steam is measured by Simplex condensation meters and paid for the same as gas, water or electric current, i. e., only as used. The profit from this operation is too good to be mentioned for publication, and the contract for steam service is for a period of ten years. Of interest, too, is the fact that the price of the steam is established through an analysis of the B. T. U. value of the coal, and the rate per 1,000 lbs. of steam will not decrease from the price named in the contract, but will increase if the price of the fuel advances or the quality depreciates.

Through the courtesy of the management of the Excelsior Springs (Mo.) Water, Gas & Electric Company, I place before you a

plan of the underground steam mains designed and installed by the American District Steam Company in 1912. It is modern in every dettail, and of especial mention and compliment is the praiseworthy fact that owner, manager, superintendent, solicitor, bookkeepers and collectors know but one rate and one form of contract, which is the law of the organization and the last word to steam consumers throughout the system. Unqualified praise by every customer is the result, and not a complaint of service was made during the past season.

I think you may be interested and may be profited by the form of contract used by this company. Its business consists of supplying electricity to residences, hotels, etc., for power and lighting and pumping water for city supply, to which service the furnishing of steam for heating was added in 1912. Mt. Vernon (Ill.) No. 3 and 4 nut and slack coal is used. Average pressure maintained in steam mains was 1½ lbs. for season of 1912-1913, with a maximum of 2 3-4 lbs. at the station during coldest weather.

An example of service is shown in the Royal Hotel, equipped with the Atmospheric system, requiring only from 5 to 8 oz. pressure at the service valves for perfect *the Kansas Gas, Water, Electric Light and Street Railway Association, Hutchinson, Kan.*, supply of steam.—*Hal C. Kimbrough before October* 9-11, 1913.

CONTRACT FOR STEAM HEATING SERVICE

This Contract entered into this.....day of..... .....19....by and between the EXCELSIOR SPRINGS WATER, GAS AND ELECTRIC COMPANY, a corporation, hereinafter called the Company, and..... ....hereinafter called the consumer;

WITNESSETH.—That for and in consideration of the sum of the monthly meter bills and all agreements contained herein, the Company agrees to furnish steam at from 1 pound to 5 pounds pressure (according to weather conditions) at the service valve in the Consumer's premises, for heating purposes in building located at No.....during the heating season for which this contract covers, barring accidents and causes beyond its control, on the following terms, towit

All heat furnished to be measured by condensation meter at the following rates
For the first 10,000 pounds condensation per month 90c per 1000 pounds.
For the next 10,000 pounds condensation per month 83c per 1000 pounds.
For the next 10,000 pounds condensation per month 76c per 1000 pounds.
For the next 10,000 pounds condensation per month 69c per 1000 pounds
For the next 10,000 pounds condensation per month 62c per 1000 pounds
All over 50,000 pounds condensation per month 55c per 1000 pounds.
No monthly bill will be rendered for steam heat, for less than $5.00.

The Consumer agrees to take steam from the Company at the above rates and upon the terms herein specified for a period of twelve months from date of this contract and agrees to pay for same as herein provided.

The Company agrees to install service pipe for the above named premises to the curb line free From said point the Company will install the service pipes at the following rates per lineal foot, towit

2 inch service $2.75 per foot.	3½ inch service $3.25 per foot
2½ inch service 3.00 per foot.	4 inch service 4.00 per foot

The consumer agrees to make all necessary changes and add tions to his heating apparatus and pipes in said buildings, that the rules and regulations of the Company may require in order to insure satisfactory service to the Consumer

It is further agreed that the service pipe and any extensions thereof, the meter connections, meter and any connections or other pipe at any time installed in said premises by or at the expense of Company. shall belong to and be subject to removal only by said Company

If the meter gets out of order and fails to register properly the Consumer will be charged at the average daily consumption under like weather conditions, as shown by the meter when in working order. or averaged by the amount charged for a corresponding month. All repairs to the meter shall be made by the Company, and no meter shall be removed or disturbed without the written consent of the Company

It is agreed that the Consumer will immediately notify the Company of the loss of steam due to defective steam trap, or from other evident causes. The Consumer hereby assumes all damages resulting from the breakage of any pipes or fittings or the escape of steam

In case the supply of steam shall be interrupted or fail by reason of accident or causes beyond the control of the Company, the Company shall not be liable for damages by reason of such failure

It is agreed that the Consumer will not transfer his right to use steam without the written permit of the Company, and if he allows such use of steam or makes such transfer without the permit, he shall be held liable for such steam as may be used.

This contract shall be continuous from year to year, upon the terms hereof, but the same may be terminated by either party on written notice to the other party, given thirty days before October first of each succeeding year, and upon such notice being given, this contract shall be no longer in force.

No promises, agreements or representations of any agent or employee shall be binding upon the Company unless the same shall be incorporated in writing into this contract before the same is signed and accepted.

This agreement shall inure to, apply to, and bind the successors and assigns of the Company.

.... Consumers.

Accepted this..... .....day of..... ... . 19 .

EXCELSIOR SPRINGS WATER, GAS & ELECTRIC CO

by . ... Manager

SCHEDULE OF EQUIPMENT

....Sq. Ft. of Direct Radiation
....Sq. Ft. of Indirect Radiation
....Sq. Ft. in mains and risers (not covered)
....Sq. Ft. Economizing coil
.... Cu. Ft. of Space

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THE PUBLISHED copies of the so-called "labor law" in New York State, which are now available, disclose the extent of the powers granted to the industrial board, which were not at all exaggerated in the preliminary reports concerning this law. When it is considered that this board has power to "make, alter, amend or repeal rules and regulations" relating to factory construction, alteration, equipment and maintenance, and to subpoena and require the attendance of witnesses and the production of books and papers, etc., some idea of the changes in prospect are apparent.

The fact that this law has not made a greater stir in the building trade is due, of course, to the failure of the State Senate, until now, to confirm the appointment of a State labor commissioner, who is *ex-officio* chairman of the board.

In the organization of the division of industrial hygiene which is to act in an advisory capacity to the industrial board, it is significant that the mechanical engineer, who is to be one of the division's four members, must be an "expert in ventilation and fire protection." The appointment of the members of this division, as well as that of all the other factory inspectors, of which "there shall be not less than 125" is directly in the hands of the commissioner of labor and now that he has taken office, events may be expected to move rapidly in this far-reaching movement to improve factory conditions.

OF HARDLY less interest are the provisions, just published, of the heating and ventilating sections of the building code of the city of Cleveland, Ohio. There the duties of the heating and ventilating engineer include the examination of plans and specifications covering heating and ventilating work and permits for the construction of same are to be granted only after he has issued the necessary certificate. The penalty for violation of the ordinance is punishable by fines of from $25 to $500. In addition to this, provision is made for the examination of existing plants and for the closing of buildings where the owners fail to comply with the changes found necessary. Both in the creation of a special office of heating and ventilating engineer and in the terms of the section itself, the new law, which became effective October 14, 1913, fulfills to a remarkable degree the conditions set forth by the heating profession for such kind of municipal regulation.

IT IS a pleasure to note that the publication of weather charts for the British Isles, similar to those for typical American cities, which have been a feature of THE HEATING AND VENTILATING MAGAZINE for several years, is being advocated for insertion in the Proceedings of the (British) Institution of Heating and Ventilating Engineers. The publication of these charts for the season of 1913-1914 for five American cities will commence with the December issue.

THE CONSULTING ENGINEER

"The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

21.—Effect of Temperature on Relative Humidity of Air.

QUESTION: If 1 cu. ft. of air at 32° F., and saturated, is raised to 82° F., without changing its volume, what will be the relative humidity?

ANSWER: Raising the temperature with a constant volume must of necessity raise the pressure. The relative humidity is the weight of vapor a given amount of air contains as compared with the maximum quantity it will hold and is a percentage. In this case, the quantity of vapor is constant, but the amount at saturation is changed, due to the increase in pressure due to the constant volume.

The total tension or pressure of a gas or mixture is the sum of the tensions of the two. The weight of dry air and water vapor in a saturated mixture of 1 cu. ft. at 14.7 lbs. (or atmospheric pressure) is, at 32° F.:

Weight of dry air = 0.08024 lbs.

Weight of water vapor = 0.0003 lbs.

Total weight of mixture = 0.08054 lbs.

The change in pressure due to the rise in temperature of the air will be the ratio of the absolute temperature or

$$\frac{82 + 459.6}{32 + 459.6} = 1.1017.$$

The tension of the water vapor at 32° F. is 0.0886 lbs. The tension of the air originally at 14.7 lbs. (or atmospheric pressure) is 14.70 — 0.0886 = 14.6114 lbs. The tension of the air at 82° F. would be 14.6114 lbs. × 1.1017 = 16.09737938 lbs.

The tension of 1 cu. ft. of steam at 82° F. will be 0.539 lbs. per square inch. As there are 0.0003 lbs. of water vapor in the final mixture, the tension of the vapor will be, at 82° F., 0.538 × 0.0003 = 0.0001617 ÷ 0.000167 = 0.96826 lbs. The tension of the mixture at 82° F. will then be 16.09737938 + 0.96826 = 17.06565 lbs. per square inch.

Prof. Kent gives the formula for the maximum amount in pounds of water per pound of air which a mixture will contain at any pressure:

$$W = \frac{K H}{2.036P - H}$$

where P = absolute pressure, or 17.06565 lbs.
W = weight of water vapor per pound of air.

K and H are looked up in a table for 82° F. One is a ratio of vapor to air, the other is the tension of the vapor in inches of mercury. So H = 1.092 and K = 0.6211.

$$W = \frac{0.6211 \times 1.092}{(.2036 \times 17.06565) - 1.092} = \frac{0.6782412}{34.74576} =$$

0.01952 lbs. of air.

There were in the original mixture 0.08024 lbs. of air, so the maximum moisture the mixture will contain, under the new condition, will be 0.01952 × 0.080239 = 0.0015666 lbs. per cubic foot. The relative humidity at 82° F., with constant volume from 32° F., will be 0.0003 ÷ 0.0015666 = 19.15% relative humidity.

The relative humidity at atmospheric pressure and 82° F. will be the maximum quantity of moisture per pound divided into 0.0003 lbs. at 82° F. The maximum quantity per pound of air is 0.001661 lbs. 0.0003 ÷ 0.001661 = 18.06% relative humidity. This is equivalent to raising the temperature of the air about 2° F. above 82° F., or about 80° F.

22.—Connecting Two Flues to One Chimney.

QUESTION: Will you advise us as to which is the best of two methods of ventilating a gas heater in the same flue with a furnace? Will the heater ventilator below the furnace opening or will the range heater above the ventilator give trouble?

ANSWER: Of the two positions the one below would be preferable, but there is little choice, as either arrangement will be apt to interfere with the furnace draft at times. The pressure within the flue, if there is any draft, will be less than the pressure without and any opening will allow the colder air to rush into the base of the flue equalizing the pressure and destroying the draft. If the products from the gas heater are raised to the same temperature as those in the flue, or above, there will be no interference with the draft in either case. When the gas heater is inoperative and the flue leading therefrom left open, the condition above described will occur and produce interference. This may be mitigated by carrying the flue leading from the gas heater up several feet within the furnace flue proper, if there is sufficient area available. It may also be carried up separately several feet beside the

furnace flue, entering on one of the upper stories, the higher the better.

In connecting two fixtures to a flue in this manner, it is impossible to prevent draft interfering if one or the other is inoperative and the flue left open. If the gas heater has a thermostatic arrangement for turning on the heat, it would be a simple matter to connect a damper in the flue that would open when the heater operated and close when it was inoperative. The precaution of carrying the gas heater flue up 8 or 10 ft. before connecting it into the chimney proper would be well as an extra safeguard.

New York's New Labor Law and How It Will Operate.

The appointment of James M. Lynch, of Syracuse, N. Y., as the Commissioner of Labor of New York, makes it possible for the first time to enforce the provisions of the new "Labor Law," as it is called, relating to labor, factories and mercantile establishments.

Our readers are aware that the distinctive feature of the new law is the provision for an industrial board which has wide powers in making investigations pertaining to the enforcement and effect of the provisions of the law, including the power "to make, alter, amend or repeal rules and regulations for carrying into effect the provisions of this chapter, applying such provisions to specific conditions and prescribing specific means, methods or practices to effectuate such provisions."

The commissioner of labor is the chairman of the board and the other members, who were appointed by Governor Sulzer, are Richard J. Cullen, formerly secretary of the State Fire Marshal Department at Albany; Charles C. Flaesch, a lawyer, of Unadilla, N. Y.; Pauline Goldmark, of New York, secretary of the New York City Consumers' League; William C. Rogers, formerly deputy commissioner of labor, and Maurice Wertheim, of New York, formerly secretary and vice-president of the United Cigar Manufacturers' Company.

The provision for the division of industrial hygiene is made under Article 4. The members of this division "shall make special investigations of factories, mercantile establishments and other places subject to the provisions of this chapter, throughout the State, and shall conduct special investigations of industrial processes and conditions." The recommendations of the division of industrial hygiene are to be submitted to the industrial board, including "proposed rules and regulations and standards to be adopted to carry out the effect of the provisions of this chapter and the division of industrial hygiene shall advise said board concerning the operation of such rules and standards and as to any changes or modifications to be made therein." All such recommendations adopted by the industrial board will have all the effect of law. They will be published in the form of bulletins. Two such bulletins have already been promulgated by the industrial board.

The membership of the division of industrial hygiene is made up of inspectors of the seventh grade, which is the highest grade of inspectors. There are to be not less than four, each of whom will receive a salary of $3,500 a year. The exact wording regarding the personnel of this division is as follows:

"Of the inspectors of the seventh grade one shall be a physician duly licensed to practice medicine in the State of New York, and he shall be the chief medical inspector; one shall be a chemical engineer; one shall be a mechanical engineer, **and an expert in ventilation** and accident prevention; and one shall be a civil engineer, and an expert in fire prevention and building construction."

The features of the new labor law here indicated, are, of course, but a very few of those embraced in this remarkable act. The complete law as published in pamphlet form by the State Department of Labor, is a book of 109 pages, 4x7 ins., with a comprehensive index.

Constitutional Amendment Passed in New York Opening the Way for Workmen's Compensation Law.

As a result of the recent election in New York State, a constitutional amendment was passed which provides that there shall be no constitutional limitation upon the power of the legislature to enact laws for the protection of the lives, safety and health of employees; for the payment of compensation for injuries to or death of employees resulting from such injuries; and for the adjustment of issues arising under such legislation. It will be remembered that in New York State an act to secure compensation for injuries sustained in the most hazardous occupations was passed in 1910. The Court of Appeals found that act unconstitutional. But the court expressed approval of the purpose of the law and branded present methods as "uncertain, unscientific and wasteful;" "economically, morally and legally unsound." The judges practically recommended that a constitutional amendment be adopted in order that a proper workmen's compensation act may be passed.

Within the last three years 21 States have enacted workmen's compensation laws and the way is now open for the passage of a similar law in New York State.

Sirocco Fan Patent Upheld.

In a suit instituted by the Sirocco Engineering Company against the B. F. Sturtevant Company for infrigement on the use of the Sirocco type of fan, a decision has recently been handed down by Judge Ray in the United States District Court for the Southern district of New York, sustaining the Davidson reissued patents covering the Sirocco centrifugal fan. The Davidson patents are owned by the sole manufacturers in America of the Sirocco fans, the American Blower Company, of Detroit, Mich.

The Sirocco fan was patented by Samuel C. Davidson, of Belfast, Ireland, in 1900. In 1907 the Sirocco Engineering Co., with Samuel C. Davidson, brought suit against the B. F. Sturtevant Co., based on the original patent. While that suit was pending the original patent was reissued as three separate patents and the suit just decided was on two of such reissue patents.

The defenses were non-invention, anticipation, non-infringement, invalidity of the reissues, because of unreasonable delay in applying therefore, unlawful broadening of the claims in scope ,and invalidity of such reissues because granted to the Sirocco Engineering Company as assignee, when in fact it was a license only, and therefore not entitled to the reissue patents.

The Sirocco fan, as is well-known, is of the multi-blade type. In his opinion, Judge Ray states: "Claim 1 of the reissued patent covers a centrifugal fan having the following elements: (1) a rotary member having numerous elongated blades, arranged lengthwise in approximately axial direction, and in substantially drum form so as to inclose within them a relatively large and practically unobstructed intake-chamber and in transverse section arranged relatively to the axis and direction of rotation to carry the fluid with them rotatively and discharge it tangentially, and (2) a means of so mounting said rotary member as to permit the tangential escape of the fluid discharged from said blades. I discover nothing at all new or novel in the means for mounting the rotary member. In the light of the specifications we are to ascertain the meaning and significance of numerous elongated blades and relatively large and practically unobstructed intake-chamber."

Claim 1, according to Judge Ray, "is so broad in and of itself as to include any and every fan having 'numerous' blades 'elongated" arranged as stated. "So far as the language of this claim is concerned," continues the opinion, "the intake-chamebr may be twice as large as a barrel and three times its length, or the size of a lamp chimney and there may be six or sixty of the elongated blades. In short, no proportion whatever is suggested. But all this is found in the specifications. Claim 5 of this patent differs from Claim 1 in that it specifies numerous elongated blades of a length approximating ten times the radial depth of the individual blades. Claim 10 differs from Claim 1 in that it specifies 'thin' elongated blades, and that the blades are 'approximately as narrow radially and as close together as set forth, and the stationery member having an eye through which the fluid is drawn coincident with said intake chamber and of a diameter substanially equal to that of said chamber.' Claim 13 differs from Claim 1 in that it specifies 'the blades being narrow radially in proportion substantially as set forth, and the stationary member comprising a casing adapted to permit the tangential escape of the fluid discharged from said blades.' The words in Claims 10 and 13 'as set forth' must refer to the dimensions set forth and stated in the specifications.

Referring to the Fournier and Cornu patent (1896) and the Levet patent (1890) which were relied upon as anticipations Judge Ray holds that in some respects Davidson's patent is a reproduction of the Fournier and Cornu patent, but it is different in many respects and an improvement.

Judge Ray did not sustain the point raised that the Sirocco Engineering Company was a mere licensee of Davidson and not entitled to the reissue patents. He also states that he does not discover any unwarranted broadening of the claims, or of the scope of the same in the reissued patents.

"After considering the voluminous record and briefs," he states, "I am of the opinion that the patents in suit disclose invention and are valid." In concluding his opinion he states.

"The main contention of the defendant on the issue of infringement is that defendant's fan does not have a relatively large and practically unobstructed intake-chamber, which is an element of the claims of the patents in suit. I do not think this contention can be sustained. The defendant supports its blades on spokes or spider arms which as matter of fact pass through the intake chamber, but they are not a material obstruction to the ingress and egress of air, and it seems to me that under the proof the intake chamber of the defendant's fan is not only relatively large, but practically unobstructed. Practically there

is no detriment to the operation of the fan, and defendant does not claim there is. These spider arms in defendant's intake chamber which do no harm, which do not impair the effectiveness and usefulness of the fan or chamber leave the chamber practically unobstructed. For practical purposes and usefulness they do not obstruct. It is not at all certain they do not add to the effectiveness of the fan. I think infringement is clear. It is not considered necessary to go into the English and German litigations and decisions all in favor of the patentability of Davidson's discovery and the validity of these claims. I have not overlooked the contention that there was such great delay in applying for the reissue that same is invalid. Under all the circumstances shown, I am of the opinion there was no undue delay. The motion to expunge testimony is denied. It has all been considered and given such weight as the court thought it entitled to.

"There will be a decree for the complainant as prayed, with costs."

ELBERT HUBBARD ON TRADE PAPERS.

3.

(This series of articles commenced in the September, 1913, issue.)

The badge of sanity is the ability to co-operate with other people; and the more people you can work with and for the bigger and better you are. It is an age of organization. Just now there are three big words. These are Reciprocity, Mutuality, Co-operation. And where do you find their principle carried out more than in your specialized trade paper?

Competition may have been the life of trade once, but it is no longer so. Competition died when the inventive genius of American engineers devised machines that should manufacture beyond the present economic wants of the people. Competition then became suicidal and destructive, and anything that is suicidal is dying—dead.

We have passed through the savage stage, the stone, the competitive, and now we are passing into the co-operative. We will not be here so very long, anyway, and soon Death, the kind old nurse, will come and rock us to sleep—and we had better help one another while we may.

The idea of the brotherhood of man is no idle, vacuous dream; and this ideal of brotherhood is coming about, not through the preaching of ethics or morality, but it is coming about as a matter of self-preservation.

Civilization is the best way of doing things. Civilization means the civil way, the mental, courteous, helpful way.

There is a natural tendency to specialize these days. The man or firm who manufactures or sells one or more products, be it soap or shoes, pianos or cabinets, should know his business. If they know it less than from A to Izzard they should busy themselves and get down to the source of supply (information)—their trade paper—and absorb with interest and studiousness all the meaty things found there pertaining and relative to their specific trade or craft. The specialized trade paper co-operates with and reflects to manufacturers and dealers the good, the best means to a successful end. Co-operation is most essential to business life.

Simply because one is in the same line of business as another man is no reason why he should attempt to destroy him. A certain amount of mutuality is absolutely necessary to live. Increased consumption is the rule of every line of human endeavor.

There are bigger markets than the world ever before offered, and there is bigger pay for the man who can eliminate the grouch, get rid of his grab instincts and regulate his gobble and guzzle. That is, don't over-eat, don't over-drink, smoke one cigar at a time, think well of everybody, especially yourself.

Be proud of the business you are in. Stand by the whole fraternity. Don't knock competitors. I have noticed this—that the smaller a man's bean the more room there is in it for peeve. Little peanut men live by themselves; they do not read their trade paper. They think they have secrets, and they are afraid of somebody getting the secret away from them. The fact is, however, we only grow as we give, and anybody who locks the world out shuts himself in.

I know hundreds of highly prosperous business men, manufacturers, dealers, jobbers, craftsmen, and I cannot recall a single instance in which the mentally successful man does not read his specialized paper. He subscribes for it and he pays for it promptly. In many instances he orders extra copies from time to time and distributes them. He is boosting the whole game all along the line. And this very fact puts him in a frame of mind where currents of success come swirling in his own direction. He is moving on the eternal tide of progress.

When you subscribe for your trade paper and assimilate it you are uplifted, inspired, given courage, pep, intellectual vim and vigor and enough trade information to make you free from the trials and tribulations

which beset the man who "doesn't know." These things all have a direct influence on the bank and mental balance.

The Trade Paper binds everybody in the business into a fraternity which spells length of days, because it "serves" and its service is based on specific knowledge.

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CORRESPONDENCE

Two Definitions of Body Temperature.

Editor HEATING AND VENTILATING MAGAZINE: Referring to my paper on "The Primary Physiological Purpose of Ventilation," (published in THE HEATING AND VENTILATING MAGAZINE for September, 1913) there is one point on which, I fear, I have not made my meaning perfectly clear, as I see I state in some places that those who think with me believe that there is a rise of the body temperature in a badly-ventilated room or in a close atmosphere generally. In physiology we distinguished between the body temperature of internal organs not subject to cooling influences, and the temperature of the skin. The former is usually constant, or nearly so; the latter is quite variable. The temperature of internal organs is constant because special means are constantly taken to keep it so, and among these means one of the most important is the variation of the amount of warm blood allowed to flow through the skin. On warm days, of course, this amount of blood is increased and the temperature of the skin goes up, thereby keeping radiation, conduction and convection of heat from the body approximately equal to heat production. On cold days, when these physical channels would cause the loss of more heat than is being produced, the blood supply to the skin is lessened to conserve the heat within the body, thereby lowering the temperature of the skin.

In the badly-ventilated room, owing to the lack of air movement, higher temperature and excessive humidity, warm blood is rushed to the skin whose temperature has already begun to rise owing to atmospheric interference with heat loss. This succeeds in getting rid of more heat and in maintaining the body (or internal) temperature, but it is done at the expense of the discomfort which comes from an overheated skin and probably of the deprivation of other organs of their normal blood supply in order to furnish the requisite amount to the skin.

I am only afraid that some people not making the distinction between body temperature and skin temperature may try, in a badly-ventilated room, the experiment of taking their temperature in the mouth with a clinical thermometer, and on finding, as they probably would, that it had not changed at all, conclude that the explanation is without basis in fact.

I shall follow with interest the work on the recirculation of air, for it would seem that it cannot fail to contribute important information to the solution of the problems of ventilation.

THEODORE HOUGH.

University of Virginia, Oct., 1913.

Baldwin on Chimneys.

LETTER TO WILLIAM J. BALDWIN.

Dear Sir:—I have just been reading your article on chimneys in the current (October) issue of THE HEATING AND VENTILATING MAGAZINE. Allowing 1 H. P. of boiler capacity to equal 100 sq. ft. of steam radiation, do I correctly interpret you as saying or meaning that a 12-in. x 12-in. chimney, 40 ft. high, will answer for a boiler carrying 100 times 13.7, or 1,370 sq. ft. of steam radiation? E. C. L.

MR. BALDWIN'S ANSWER.

I have your letter of October 17 and in reply will say that your deductions are right. A chimney 40 ft. high, 1 ft. x 1 ft., is equal to 13.7 H.P. A circular chimney of the same area would have slightly better efficiency.

Permit me also to call your attention to the table on Page 26 and say that the calculations are all on a chimney of 1 sq. ft., so that if you have a circular chimney twice the diameter, your areas will be 4 and your efficiencies will be 5.657. Do not confound the first column, "diameters," with square feet.

I will endeavor to add a table to my article in another issue, so one will always be able to pick out the capacity for chimneys for areas greater than 1 sq. ft.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Annual Meeting of New York Chapter.

A representative attendance marked the opening meeting for the season of the New York Chapter, at the Engineering Societies Building, October 20. Being also the annual meeting of the chapter, reports were presented by the officers detailing the activities of the past year which were so successfully carried out, and this was followed by the report of the tellers, announcing the newly-elected officers.

President Frank G. McCann presided. Secretary Joseph Graham reported the present membership as 78. The receipts for the year were $350.50, which, added to the balance from last year, amounted to $450.25. The expenditures were $314.77, leaving a

balance of $135.48. Treasurer Arthur Ritter presented his report, showing the balance as given.

For the committe on tests, James A. Donnelly read a report in the absence of Ralph C. Taggart, chairman. The report referred to the ventilation test of a school building which formed the subject for one of the chapter's meetings last year. It was also stated that letters had been sent to technical schools with the purpose of ascertaining if they were engaged in making any tests of heating apparatus or would cooperate in such tests. It was learned that Stevens Institute was interested in the establishment of a standard method of measuring radiating surfaces, while the Massachusetts Institute of Technology is engaged in tests of insulating materials. The latter institution would be glad to cooperate in tabulating information relative to the flow of heat through the so-called non-conductive materials. Prof. Breckenridge, of Yale University, wrote that he was making tests of small heating boilers and of hot blast coils. The committee suggested the need of experimental work in connection with friction in the flow of steam through elbows and fittings, and also in the matter of velocities in steam pipes and its effect in preventing the water of condensation from flowing back against the steam under various conditions. It was brought out that a new laboratory is being installed at the University of Rochester, where tests may be made.

The committee strongly recommended a wider cooperation between the chapter and the technical institutions in the procuring of data.

Frank T. Chapman reported that the committee on moving picture show places was watching the situation but had nothing special to report at that time. He stated that the new building code for New York City, now pending, would have no bearing on the ventilation of picture theatres.

Frank K. Chew and Homer Addams, who were the tellers, reported the election of the following officers: President D. D. Kimball; vice-president, J. I. Lyle; secretary, W. T. Goodnow; treasurer, Arthur Ritter; board of governors: Frank G. McCann, W. S. Timmis and W. H. Driscoll.

On behalf of the chapter Mr. Chew then presented to the retiring secretary, Joseph Graham, a set of gold cuff buttons, a moonstone scarf pin and a $20 gold piece, as a token of the chapter's appreciation of his services as secretary during the three years of the chapter's career. After a response by Mr. Graham, the retiring president resigned the chair to Vice-President Lyle.

The following amendments, which were approved at the meeting, will be submitted to the membership of the chapter for mail ballot: Date of annual meeting changed from October to April; the payment of a salary to the secretary, the amount to be determined by the board of governors; the nomination ticket to contain the names of two members for each office; and an extension of the time for the payment of dues.

A motion offered by Mr. Donnelly was passed providing for the appointment of a committee of three to arrange for a junior course in heating and ventilation at one of the educational instituttions in New York.

A resolution was also passed providing for a discussion of vacuum steam heating at the November meeting.

Opening Meeting of the Illinois Chapter.

The reading of the reports and the election of officers formed the principal business at the annual meeting of the Illinois Chapter, held at the Bismarck Cafe, Chicago, October 13. President J. M. Stannard welcomed the members and thanked them for their support and cooperation during his term of office. Secretary W. L. Bronaugh, in the course of his report, read two letters from Dr. Vernon Hill and J. H. Davis urging some legal action that would prevent the covering up on ventilation installations before inspection. The treasurer's report, read by Secretary Bronaugh, in the absense of Treasurer Kehm, showed the treasury to be in satisfactory condition.

For the ventilation committee, S. R. Lewis told of the plans for next winter's experiments by the Chicago Ventilation Commission at the Chicago Normal School. One arrangement that will be tried out provides for the introduction of air at the breathing level at a lower temperature than that for the rest of the room. The tests as now planned will cover the whole of the coming year.

Following the report of the tellers, the following officers were declared elected: President, H. M. Hart; vice-president, Charles F. Newport; secretary, W. L. Bronaugh; treasurer, August Kehm; board of governors: J. M. Stannard, S. R. Lewis and R. A. Widdicombe.

The presence of Dr. Vernon Hill, of the Chicago ventliation inspection bureau, led to an interesting discussion on the present situation regarding the enforcement of the ventilation ordinance. Dr. Hill reviewed the efforts of the Motion Picture Exhibitor's League to appeal or amend the ordinance and called attention to the fact that calling for 1,500 cu. ft. per minute does not

mean getting it and that an apparatus supposedly designed for supplying that amount frequently be found to be supplying considerably less. He stated that in only three cases out of 168 installations was the specified amount equalled or exceeded.

Massachusetts Chapter Elects New Officers

Members of the Massachusetts Chapter met in Boston, October 15, for the opening meeting of the season. New officers were elected as follows: James W. H. Myrick; vice-president, Charles F. Eveleth; secretary, Frank Irving Cooper; treasurer, William T. Smallman; board of governors: Albert B. Franklin, Charles Morrison and H. W. Whitten.

American Society of Mechanical Engineers.

Among the papers to be read at the forthcoming annual meeting of The American Society of Mechanical Engineers, in New York, December 2-5, 1913, is one on "Tests of Vacuum Cleaning Systems," by J. R. McColl, of Detroit.

Lecture on School Ventilation.

"Common Sense in the Ventilation of School Buildings" was discussed by William J. Baldwin, of New York, heating and ventilating engineer, in a conference conducted by him at the Brooklyn Institute of Arts and Sciences, October 4. Slides showing the mechanical equipment in typical New York City school buildings were displayed. The speaker showed the improvement in the methods of school ventilation of today and the advances made in 30 years.

Of particular importance, he stated, are the provisions now being made by the New York City Board of Education for anaemic children, or those who are mentally deficient. The class rooms for these children are warmed and ventilated by the regular methods, but in addition, the window arrangement on three sides of the rooms is of a character to satisfy the most advanced advocates of education in the field or on the roof. The children study in reclining chairs and are screened from the sun. They are fed and have an hour's sleep after their luncheon. In the cold weather provision is being made to give them their siesta in sleeping bags.

Mr. Baldwin pointed out that while the medical men were freely criticising present methods they were not making any notable recommendations for bettering the situation. He declared that theories regarding the effect of ventilation on blood pressure, etc., would need further confirmation before they could be generally accepted and that it was of more importance to learn how to dry the air when too damp than to moisten it when dry.

The Case of the Heating Contractor Against the General Contractor.

Under the heading of "An Appeal to Architects, Consulting Engineers and Others," the National Association of Master Steam and Hot Water Fitters is sending out a leaflet expressing "the unsatisfactory conditions that now exist as the result of the practice of including the heating, ventilating and power plant equipment in the general building contract." One of the points brought out in the leaflet is that the general contractor seldom if ever awards the contract to the heating contractor whose figure he used to win the contract. How this comes about is explained in the leaflet: "After the contract has been awarded to him, he starts in to get new figures, often stating in his requests for new estimates, 'We have been awarded the general contract,' etc., etc., showing plainly he is not dealing in a fair manner with the parties who originally estimated for him and helped him to obtain the contract."

General contractors are classified as: "Those who meet their obligations, whether the owner pays them or not; those who meet their obligations upon receipt of payments from the owner; those who receive payment from the owner and pay the subcontractor only when compelled to do so; those who never pay at all; those who award the contract to the lowest bidder whose estimate they received when estimating the work; and those who ask for and receive estimates from which contracts are awarded who then compel subcontractors to refigure work, before subletting."

The leaflet closes with a request that principals deal direct with heating contractors, on the ground that when the owner or architect does this he will get a better apparatus and also save money, "as the general contractor must add his profit to the estimates received."

New Standards for Brass Flanges and Pipe Thread Gauges.

Announcement is made by the Committee of Manufacturers on Standardization of Fittings and Valves of the adoption of the "American Standard Flange Dimensions for Brass Flanges" and of the "Application of Briggs Pipe Thread Gauges for Standard and Extra Heavy Pipe, as adopted by the Manufacturers' Standardization Committee and Approved by the American Society of Mechanical Engineers and the Committee

on International Standard for Pipe Threads and the Pratt & Whitney Company."

The new brass flange schedule was adopted September 17 and becomes effective January 1, 1914. The new schedule covers sizes from ¼-in. to 12 in. diameter and for pressures up to 125 lbs. (standard weight) and up to 250 lbs. (extra heavy).

The new application of the Briggs Pipe Thread Gauges is in accordance with a resolution adopted by the Manufacturers' Standardization Committee September 17. The new gauges consist of one plug and one ring gauge for each size. The plug gauge is the Briggs standard pipe thread as adopted by the manufacturers of pipe-fittings and valves and recommended by the American Society of Mechanical Engineers in 1886. The plug has a flat or notch indicating the distance that the plug shall enter the ring by hand. The ring gauge is to be known as the American Briggs Standard, adopted by the Manufacturers' Standardization Committee in 1913, and recommended by the American Society of Mechanical Engineers, the Committee on International Standard for Pipe Threads and the Pratt & Whitney Company, manufacturers of gauges.

Copies of circulars giving additional details of both standards are procurable through W. H. Douglas, secretary of the Manufacturers' Committee, 30 Church Street, New York.

An Industrial and Technical Education Conference.

With a view of solving the problem of training men for advancement in the industries a section of the Public Education Association of Philadelphia has been organized, and is known as The Industrial and Technical Education Conference. Membership consists of educators and employers, and the purpose is to seek the solution of the problems arising from the needs of the vast numbers of young people who have never had proper opportunities for securing that knowledge which will pave the way to better service and higher responsibilities.

It is hoped that the movement thus started will spread to include not only local representatives, but all those employers whose employees find in the large city opportunities which cannot be offered nearer. This means extending the work a great many miles from Philadelphia, for classes could easily be arranged outside the city, managed by experienced teachers who are specialists in any given line of instruction.

Among the educational institutions interested in organizing the proposed section are the Central Educational Institute of the Y. M. C. A., Drexel Institute, The Franklin Institute, School of Industrial Arts, Spring Garden Institute, Temple University and the Wagner Free Institute of Science, in addition to representatives of the Philadelphia trade schools and the Philadelphia and Camden public schools. The conference has taken quarters at 1015 Witherspoon Building, Philadelphia.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the articles mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

DISTRICT HEATING

The Design of Central Heating Systems. A. G. Christie. Considers the advantage of the central heating plant, its utility, location, design, etc. 5500 w. Can. Engr.—July 17, 1913. Serial, 1st part. 20c.

ELECTRICAL HEATING

Efficiency and Cost of Electrical Heating. H. O. Swoboder. Third and concluding article of a series. Considers the four methods of carrying the electrically generated heat to the point where it is required. 2500 w. Elec. Jour.—July, 1913. 20c.

HEATING SYSTEMS

High-Pressure Steam Heating vs. Hot Water By-Product Plant. Ira N. Evans. Discusses the financial possibilities of a vacuum hot water heating system. 4000 w. Power—July 29, 1913. 20c.

HOSPITAL PLANT

The Service Equipment of the Samaritan Hospital,Troy, N. Y. C. F. Herington. Illustrates and describes an example of advanced practice in heating and ventilation. 2500 w. Eng. News—July 17, 1913. 20c.

VENTILATION

Ventilation System of Hotel McAlpin. Illustrated description of the provisions for supplying an abundance of filtered air. 2500 w. Met. Work—July 25, 1913. Serial, 1st part. 20c.

AIR COOLING.

Air-Cooled Jacketing in Hollow Walls by Electric Fans. J. W. Meares. Abstract of a paper read before the Calcutta Sec. of the Inst. of Elec. Engrs. Suggestions for mitigating living conditions in the new buildings at Delhi, India. 1700 w. Elec'n, Lond—Aug. 1, 1913. 40c.

HEATING SYSTEMS.

Physical Action of Steam and Forced Hot-

water Heating Systems. Ira N. Evans. A discussion generally favoring the hot-water system 3000 w. Power—Aug. 12, 1913. 20c.

Officers Nominated by American Society of Heating and Ventilating Engineers.

The following have been placed in nomination by the nominating committee of the American Society of Heating and Ventilating Engineers:

For president, Samuel R. Lewis.

For vice-president, Edmund F. Capron.

For vice-president, Dwight D. Kimball.

For treasurer, Jas. A. Donnelly.

For council: Samuel R. Lewis, Edmund F. Capron, Dwight D. Kimball, Jas. A. Donnelly, J. F. Hale, J. R. Allen, W. W. Macon, F. T. Chapman, J. M. Stannard, F. G. McCann, F. I. Cooper, H. M. Hart.

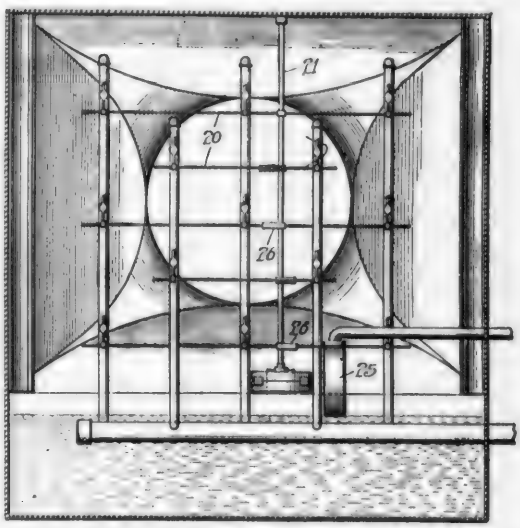
The Sterling Air Purifying and Cooling System.

We take pleasure in announcing to the trade that another new member has been added to the air washer family, to be known as the Sterling air humidifying and air washing apparatus, designed and manufactured by Blomfeldt & Rapp Co., Chicago, Ill. This firm has been specializing for twenty years in the design and construction of machinery, but upon the addition to the firm of A. A. Blomfeldt, it has branched out into the manufacture of air purifying apparatus. Mr. Blomfeldt has been associated with the Acme air washer people for over four years in the capacity of mechanical engineer and designer of ventilating systems and air washers. With this experience and being a graduate of the University of Illinois in mechanical engineering, his qualifications for successfully conducting this line of business are evident.

The Sterling air washer is considered an improvement over many systems in that it has incorporated in its design the operation of an automatic flushing mechanism to flush the spray system of accumulated dirt and impurities carried in suspension in the circulating water. This feature has proved to be an important element in the successful operation of an air washer. Also greater dependability in the operation of the apparatus is secured through a spray head simple in design and offering a minimum of internal obstruction.

A new feature in the Sterling spray system is shown in the use of a vertical cam shaft operated by a water motor, to trip the spray heads in a series of successive operations, without breaking the form of spray during the flushing periods. A series of inclined trips are placed to engage an adjacent lug on the cross rods connecting the spray heads, and operated by the movement of the vertical cam shaft. The flushing operation can be regulated to actuate from 10 to 20 times an hour by controlling the supply of spray water to the motor.

Another idea of incorporating a large wetted surface in the direct path of the air flow materially adds to the cleansing efficiency of the sprays. These consist of a series of small, vertical self-cleansing deflecting blades located behind the spraying system, and are in addition to the regular eliminating plates.



STERLING AIR WASHER, SHOWING VERTICAL CAM SHAFT TO TRIP SPRAY HEADS.

The manufacturers of the Sterling apparatus state that they are prepared to undertake the development of humidity problems and air purifying systems, in connection with ventilation systems, for printing and lithographing plants, piano store rooms, varnish and veneer drying rooms, photographic and film curing processes, besides the application of the washed air system to public buildings, theatres and residences.

Another line of Sterling apparatus is represented in the small, portable Sterling air washers. These units are intended for use in small installations and where space for installation is limited. The Sterling portable washers are built in capacities of from 100 to 5,000 cu. ft, of air per minute and represent a complete ventilating plant, including a fan direct driven by an electric motor, air washing chamber, tank, eliminator, spraying system and air distributors. Economy of power and floor space and efficiency of operation are emphasized as the features of this apparatus.

The company is now preparing a booklet containing full information, with illustrations, of the Sterling line, which may be had upon request.

SPRAY HEAD OF THE STERLING AIR WASHER.

The Sturtevant Air Washer.

The new Sturtevant air washer, which has been on the market more than a year and which has been installed in many buildings, although no notice has heretofore been made of it in technical journals, embodies what the makers believe to be the most practical and satisfactory air washer principles. The air washer, which is the result of careful study and experiment on the part of its builders, has proved its efficiency in actual service and has realized all that was hoped for it.

The Sturtevant air washer, whose external appearance may be judged from Fig. 1, is of the rain spray type, with horizontal eliminators. It consists of three parts, the spray chamber in which the washing actually occurs; the eliminators, which remove all entrained moisture from the air, and the sump or tank, which forms the bottom of the air washer and into which falls all of the water from the spray pipes and the eliminators. In Fig. 1 can be seen the eliminators, the spray chamber and the sump. Besides these parts, there is necessary a recirculating pump for creating a circulation of water in the spray pipes. When installed in a ventilating system the arrangement shown in Fig. 2 is used. Here it will be seen that the air enters at the left, passes through a tempering coil and heater into the air washer and from thence through a second heater into the fan. The pump and water piping are shown in this drawing and a portion of the casing has been broken away in order to display the eliminators of the air washer.

The spray by which the washing process is accomplished may be one of three types. There is the mist type, in which the water

FIG. 1.—THE STURTEVANT AIR WASHER.

is atomized by being forced through properly designed nozzles, so that the spray chamber is completely filled with the nebulous mist. The intimate contact of water with air is evidently easily obtained by this type of spray. In direct contrast is the sheet of water type used in some washers, in which the sheet of water is formed by properly designed nozzles. Through this sheet of water the air must pass, and it will be seen that so long as this film of water remains unbroken the air must be effectively cleaned. The rain type of spray is similar to neither of the others, for here the spray is formed into rain-like drops which fill completely the interior of the air washer chamber like a heavy rainstorm

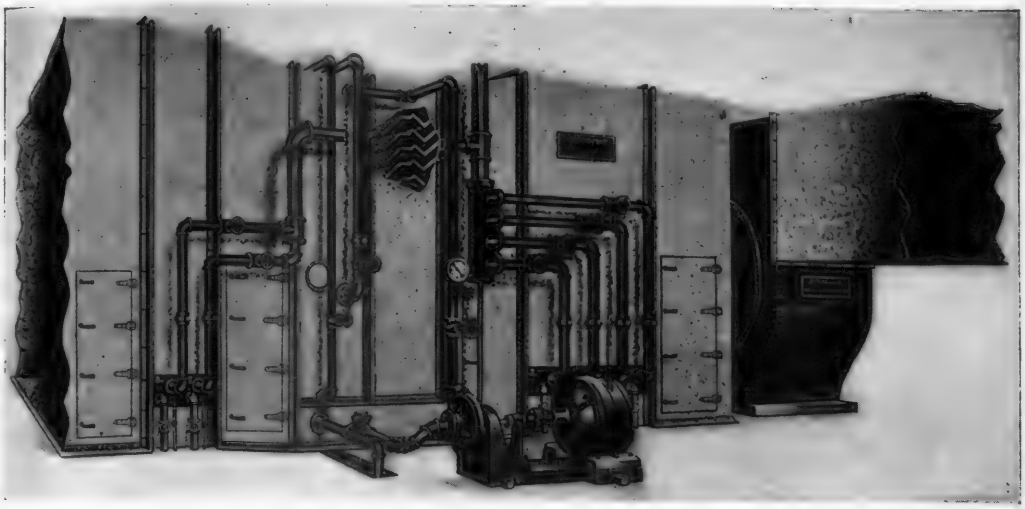


FIG. 2.—TYPICAL INSTALLATION OF STURTEVANT AIR WASHER, SHOWING TEMPERING COILS, HEATER AND MULTIVANE FAN.

falling from the top to the bottom of the spray chamber. The rain type was chosen by the Sturtevant Company as being the most satisfactory for air washers for ventilation work.

The type of nozzle forming the spray in the Sturtevant air washer is shown in Fig. 3, while Fig. 4 shows how these are attached to the spray pipes. The design of these nozzles is unique and permits of a large orifice, so necessary to prevent clogging. No flushing device is required with this type of nozzles and its efficiency is said to be remarkable. The water issuing from the orifice under pressure created by the recirculating pump strikes against a lip curved over this orifice and is broken into a spray, spreading out broadly, due to the shape of the lip, and thus filling the chamber. The water falls into the sump below. The spray chamber is constructed of galvanized steel and the interior is painted with black asphaltum.

The air passing through the rain-like spray is cleansed of dirt and impurities and finally comes in contact with the eliminators, whose position in the air washer can be seen in Fig. 1, and whose shape and construction can be seen in Fig. 5. These eliminators are placed horizontally across the air washer and form between them broken passages through which the air must pass in order to leave the spray chamber. It will be noticed that the surface of each eliminator is perforated in such a way that small lips of metal are formed and that the edge of each eliminator is serrated. The air laden with moisture strikes against the sharp edges of these serrations and perforations and against the edges of the metal lips, where the entrained moisture is removed, so that when it leaves the eliminators the air contains no unevaporated moisture. The water dripping from these eliminators further increases the efficiency of the washing process and drains into the sump below. The eliminators are constructed of galvanized steel, galvanized after being punched and formed, and are painted with black asphaltum.

The sump, which may be constructed of galvanized iron or of concrete, is a tank into which falls the water from the spray chamber and eliminators. It is provided with an overflow, which maintains a constant level of water within, and with a drain and strainer. A float valve maintains the water supply. The water is drawn from the sump by a small centrifugal pump, shown in Fig. 2, and is delivered by this pump to the spray pipe under sufficient head to create the desired spray. The

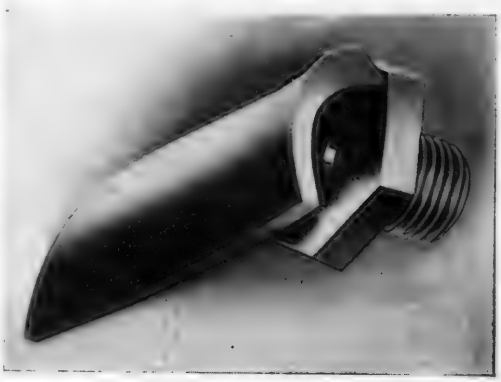


FIG. 3.—NOZZLE, STURTEVANT AIR WASHER.

FIG. 4.—SPRAY PIPE OF STURTEVANT AIR WASHER, SHOWING METHOD OF ATTACHING NOZZLES.

pump may be driven by electric motor, pulley, belt, steam engine or steam turbine. The strainer consists of two concentric, perforated, cylindrical screens inclosed at the ends by aluminum castings. The pump suction pipe draws the water from within the two screens. As the orifices of the nozzle are comparatively large, the mesh of the strainer is not so fine that excessive power is required to drive the pump, and as a second wire strainer in the washer pipe is unnecessary another saving in power for the pump is thereby effected.

Some of the most important buildings in which the Sturtevant air washer has been installed recently are:

Bureau of Engraving and Printing, Washington, D. C.; Bancroft Hotel, Worcester, Mass.; St. Paul's Hospital, Vancouver, B. C.; Empress Theatre, Sacramento, Cal.; the Rogers Building, Vancouver, B. C.; Victoria High School, Vancouver, B. C.; Standard Oil Building, San Francisco, Cal.; Oakville Company, Oakville, Conn.; the Rosenberg Company, Rochester, N. Y.; Lutcher Memorial Church, Orange, Texas; Waterbury Brass Company, Waterbury, Conn.; Bosch Magneto Company, New York, N. Y. Other air washers have been sold for various industrial purposes.

A new catalog describing the Sturtevant air washers has just been issued by the Sturtevant Company. This catalog contains forty pages and describes the air washer and its uses. It also contains illustrations of the various parts, valuable psychrometric tables and an excellently arranged psychometric diagram, together with a table of sizes and capacities of the Sturtevant air washer. The catalogue may be had by addressing the B. F. Sturtevant Company, Hyde Park, Boston, Mass.

A STATEMENT.

Statement of the ownership, management, etc., of THE HEATING AND VENTILATING MAGAZINE, published monthly at New York, N. Y., required by the Act of August 24, 1912.

Name of— *Post-Office Address.*

Editor, A. S. Armagnac, 1123 Broadway, New York.

Business Manager, Gustave Petersen, 1123 Broadway, New York.

Publisher, Heating and Ventilating Magazine Co., 1123 Broadway, New York.

Owners (if a corporation, give names and addresses of stockholders holding 1% or more of total amount of stock):

A. S. Armagnac, 1123 Broadway, New York.

Gustave Petersen, 1123 Broadway, New York.

Known bondholders, mortgagees and other security holders holding 1% or more of total amount of bonds, mortgages, or other securities:

None.

(Signed) A. S. ARMAGNAC, Editor.

Sworn to and subscribed before me this 30th day of September, 1913.

(Seal) (Signed) A. L. SCANTLEBURY.

Notary Public No. 248, Kings County Certificate filed in New York County.

(*My commission expires March* 31, 1917.)

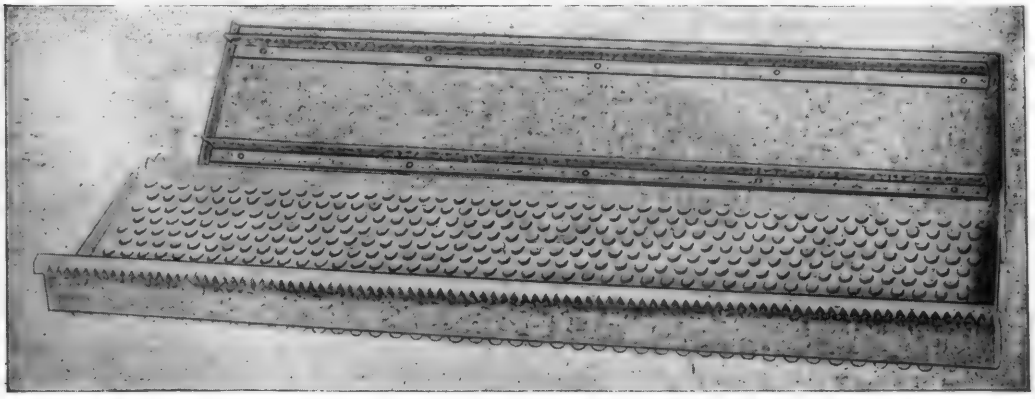


FIG. 5.—ELIMINATOR, STURTEVANT AIR WASHER.

Modern Vacuum Cleaning Apparatus

13.—Santo-Duplex Stationary Vacuum Cleaners.

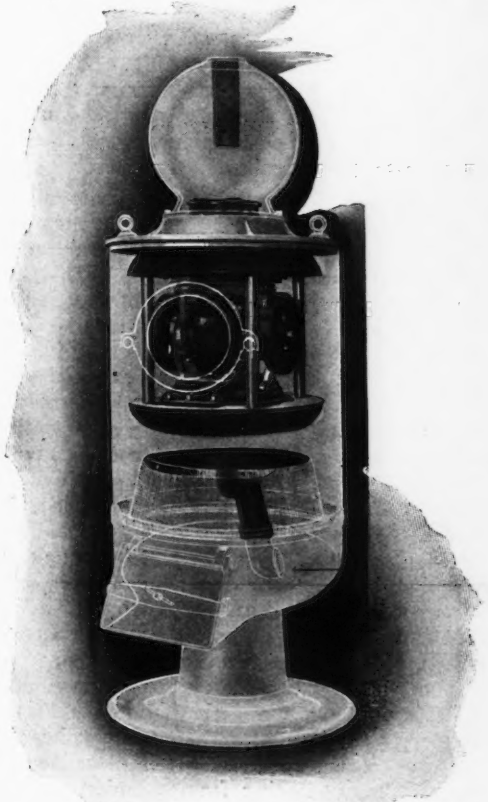
The accompanying semi-phantom view of the Santo-Duplex stationary vacuum cleaner gives an idea of the construction of this interesting machine which, as will be seen, is notable for its simplicity, while its manufacturers, the Keller Mfg. Co., 21st Street and Allegheny Avenue, Philadelphia, emphasize, as additional features, its durability, efficiency and economy.

When the machine is in operation the dust-laden air enters at the point shown by the arrow. Here the air velocity is temporarily decreased to permit of the complete separation of dust from air by means of the separators screen which is of the Santo dry separation type.

The pumping mechanism is suspended on springs to eliminate vibration, while power is transmitted to the pumps by direct connection to the motor shaft with balanced ball-bearing eccentrics. No exhaust connections to chimney or sewer are used with this apparatus as the dust separation, it is stated, is accomplished without them. It has also been found that oiling of the motor and eccentric bearings is only necessary three or four times a year under ordinary conditions. The manufacturers state that this type of machine has given the equivalent of 25 years of cleaning service without a stop for repairs or adjustments.

In common with other mechanical devices, efficiency in vacuum cleaners is determined by the ratio of useful work performed to the power required or energy absorbed by the machine. Therefore, the most efficient stationary vacuum cleaner is the one which will perform satisfactory cleaning with the lowest power requirements. Attention is called to the fact that the Santo-Duplex requires but a ¼-H. P. motor, which is, in many respects, a considerable advantage when it is realized that motors of more than ¼-H. P. cannot be operated from ordinary electric light currents, but necessitate special power current and wires, which figures both in the amount of electricity consumed and in the cost of installation. In addition, no special starting devices or relay control switches are required with a ¼-H. P. motor.

There are but two distinct types of stationary vacuum cleaning machines. One type relies solely upon the large volume of air handled for accomplishing its cleaning, being incapable of creating any appreciable vacuum owing to its principles of construction. The other type handles a smaller volume of air, but at a higher vacuum, which gives to the air entering the cleaning nozzle a high velocity. With machines of the Santo-Duplex type, designed for a one-sweeper plant, it has been found that piping larger than 1½-in. in diameter is unnecessary, for the volume of air that can be effectively handled through a 1½-in. pipe and a 1-in. hose is ample, since the cleaner



PHANTOM VIEW OF SANTO-DUPLEX STATIONARY VACUUM CLEANING MACHINE.

is so constructed that uniform high velocity is maintained under the varying conditions of cleaning. The Santo-Duplex is equipped with specially-designed and patented pumping mechanism aranged to maintain a uniform high velocity of air entering the cleaning nozzle. The manufacturers, who also make the Santo portable electric vacuum cleaner, as well as a smaller cleaner, state that nearly 50,000 of their machines have been marketed to date.

Trade Literature.

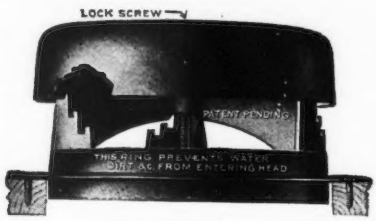
DUNHAM REDUCING PRESSURE VALVE AND VACUUM PUMP GOVERNOR are new products of the C. A. Dunham Co., Marshalltown, Ia., manufacturers of the Dunham vacuo-vapor system of heating. They are described and illustrated in a new bulletin (No. 9). The company states that both devices have been produced to work in conjunction with the company's other specialties and are made with the same rigid care. The information contained in the bulletin is intended to be sufficiently comprehensive to enable one to order intelligently and to determine what piping will be necessary to properly install the devices. Size 6x9 in. (standard). Pp. 8, punched for binding.

STARBUCK'S TOOLS FOR PLUMBERS, STEAM AND GAS FITTERS, SHEET METAL WORKERS, ELECTRICIANS, ETC., manufactured and sold by R. M. Starbuck & Sons, Hartford, Conn., are the subject of a new catalogue for 1913-1914. Size, 3½x6-in. (standard). Pp. 56.

INDUSTRIAL OZONATORS, for ventilation and air purification, for use in manufacturing processes and for water purification, are discussed in a newly-issued bulletin (No. 850) issued by the Sprague Electric Works of the General Electric Co., New York, manufacturers of this apparatus. Typical illustrations are given of different sizes showing that the essential parts of this equipment are an ozone generator, a transformer, an air filter and a controlling panel. The generating units are cast-iron boxes which are provided with ozone-producing tubes. An electric discharge takes place between the inner enameled steel tube and the outer glass tube. Air is passed through the machine between the inner and outer tube, where it becomes ozonized, and thence is carried through the piping to the point of application. The ozone generating units are supported on structural steel frames, two units being mounted on a single frame. A transformer is employed for raising the voltage of the line to that required. It is placed within one of the supporting frames underneath the generating units. The transformers are so arranged that the voltage of the high tension current supplies to the machine may be varied at will, and the ozone output of the generator thereby regulated. The air filter consists of a sheet metal box through which the air passes before entering the air chamber. In its path through the filter the air first passes over a bed of calcium chloride, for removing the moisture and thence through a fine screen and a layer of cotton waste, to screen it of dirt and dust. If a supply of air at suitable pressure is not available, a motor-driven blower is supplied as an intergral part of the equipment. The catalogue includes typical elevations showing the arrangement for installing the ozonators. Size 8x10½-in. Pp. 8, punched for binding.

GARDNER AUTOMATIC FEED PUMP AND RECEIVER, also Gardner Duplex Steam Pumps are subjects of newly-issued circulars, published by the Gardner Governor Co., whose New York office is in the Singer Building, at 149 Broadway. This office is in charge of T. T. Burchfield, sales manager, and W. S. Ransom, resident manager. The company announces that in addition to this office, it will carry in its warehouse at Philadelphia a large stock of Gardner goods, including duplex steam pumps, duplex power pumps, vertical air-cooled compressors, water-cooled compressors, horizontal belt and steam actuated compressors, steam separators, pump governors and engine governors. The circulars contain illustrations and construction details of the company's line. Size of each catalogue, 6x9-in. (standard).

KNOWLES IMPROVED NOTCH STYLE MUSHROOM VENTILATOR AND AIR CONTROLLING HEAD is the title of a new circular issued by the manufacturer, George E. Knowles, showing the latest form of this device, which is for use in connection with indirect or mechanical systems of heating and cooling auditoriums. It is placed



NEW TYPE OF KNOWLES MUSHROOM VENTILATOR, WITH RING TO PREVENT ENTRANCE OF WATER OR DIRT.

on the floor underneath the seats and there connected with the air duct. It will be noted that the new type includes a ring added to prevent water, dirt, etc., from entering the head. It is said to be equally effective with either up-draft or down-draft systems. It is made in four sizes, ranging from 4 to 8-in. diameter.

MOREHEAD BACK-TO-BOILER SYSTEM RETURN, NON-RETURN, VACUUM AND CONDENSER TILTING TRAPS, made by the Morehead Mfg. Co., Detroit, Mich., are featured in a new catalogue issued by this company, giving exhaustive information on the various types, together with their uses and points of advantage. The fact that the company has specialized for 22 years in the manufacture of steam traps is an assurance that the construction and operating features of these traps have been carefully worked out. The illustrations give an accurate idea of the simplicity of the Morehead steam trap installations and the actual work they are doing under widely varied conditions of service. An illustration of special interest is one showing, by numbered arrows, eight fundamental

features on which the success of the Morehead return steam trap is based. The catalogue is handsomely gotten up and is a notable addition to the trade literature of the year. Size 6x9-in. (standard). Pp. 48.

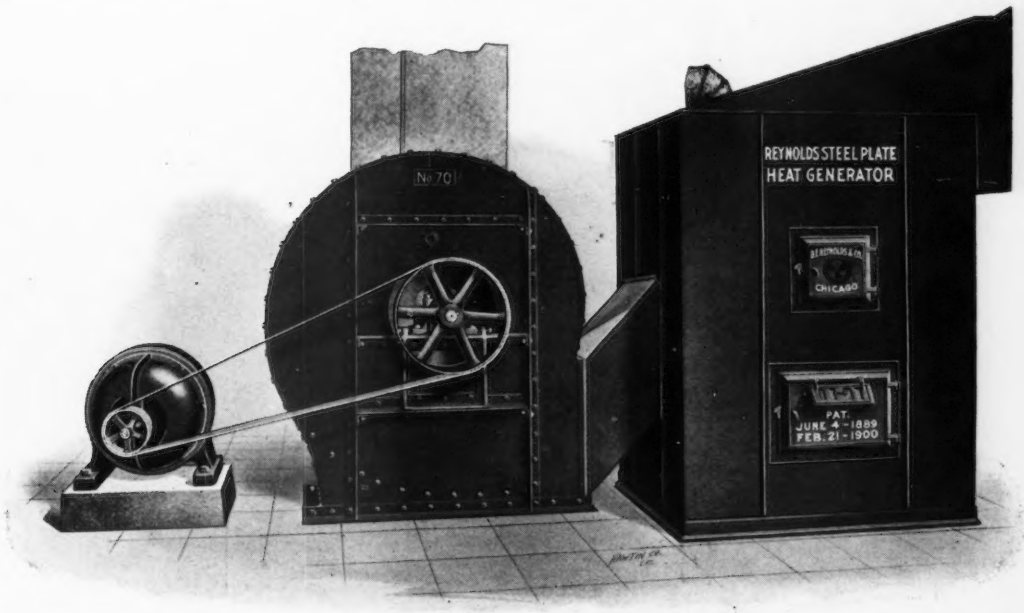
STURTEVANT AIR WASHERS, the new product of B. F. Sturtevant Co., Hyde Park, Mass., is the subject of Catalogue No. 225. The Sturtevant air washer has been on the market for over a year, although no public mention has been made of it until now. In this way the company has been able to test the air washer under actual working conditions. Some of the installations made are as follows:

New Building, Engraving & Printing Bureau, Wash., D. C.
The Rodgers Building, Vancouver, B. C.
Victoria High School, Vancouver, B. C.
Standard Oil Building, San Francisco, Cal.
St. Paul's Hospital, Vancouver, B. C.
Empress Theatre, Sacramento, Cal.
Bosch Magento Co., New York City.
Oakville Co., Oakville, Conn.
Waterbury Brass Co., Waterbury, Conn.
Rosenberg Co., Rochester, N. Y.
New Bancroft Hotel, Worcester, Mass.

In addition to a description of the air washer itself, the catalogue contains valuable hygrometric data, including charts, which add much to its usefulness. Size 6½x9-in. Pp. 40.

VENTILATION IN THE PUBLIC BUILDING, featuring the Reynolds system, using the Reynolds steel plate heater, made by B. F. Roynolds & Co., Chicago, Ill., is a new publication explaining the system in detail. A separate catalogue is devoted to the Reynolds steel plate heater for use with warm air or combination warm air and hot water heating systems, for heating all classes of buildings. The heater is designed to burn hard or soft coal, coke or wood. Its principal feature is a steel shell located in the central part of the furnace and surrounded by the air chamber on all sides. This shell, or radiator, as it is called, shuts off all combustion from entering the air chambers. A series of deflecting flanges extend from the radiator to the outer shell of the heater, which serve both to increase the heating surface and mix the air.

LOW PRESSURE RECEIVER OIL SEPARATORS, for use in purifying engine exhaust steam which is to be utilized in low-pressure or mixed-flow turbines, are described in Section E of the Cochrane separator catalogue, issued by the Harrison Safety Boiler Works, 3180 No. 17th St., Philadelphia, Pa. The object of using these separators is first, to prevent oil in the exhaust from fouling the turbine blades and passages and the condenser tubes and rendering the condensate unfit for boiler feed, and, secondly, to remove from the exhaust steam the water of condensation formed in the engine. As each pound of water in the steam entering a low pressure turbine will cause the consumption of one to two pounds more steam, it is stated that the separators soon pay for themselves in the saving in steam and in the increased capacity of the turbines. The separators employed for this service have extra large wells or receivers, which serve not only to store water until it can be drained away by the traps, but also act as muffle tanks to smooth out the pulsations in the flow of the steam from the engine.



STANDARD STEEL PLATE BLOWER IN CONNECTION WITH AN ELECTRIC MOTOR USED WITH REYNOLDS STEEL PLATE HEAT GENERATOR.

TABLE OF ESTIMATED RADIATION, by Harry B. Perrigo, New Haven, Conn., is the title of a pocket folder of celluloid giving in tables the amounts of radiation required for both steam and water, corresponding to the glass, exposed wall and cubic contents losses. A list of special allowances or deductions are added for varying conditions. Size 4½ x 7¼ in. Pp. 4. Price $1.00. May be obtained through the book department of THE HEATING AND VENTILATING MAGAZINE.

New York Fold of the United Bunch of Sheep, the organization of salesmen, held its annual dinner October 11, at Reisenweber's. The dinner followed a matinee at the Astor Theatre, where the "Seven Keys to Baldpate" was on the boards. A pleasing innovation was the presence of the wives of many of the members who attended both the theatre and dinner. Bell Sheep J. H. Gannon was in charge.

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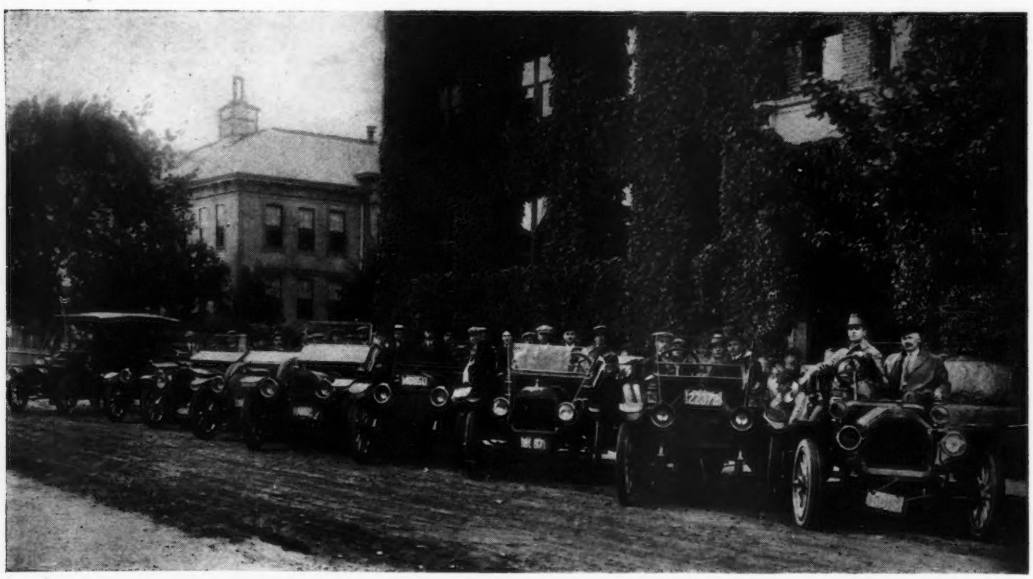

B. F. STURTEVANT COMPANY'S DEPARTMENT HEADS AND ASSISTANTS ON ANNUAL OUTING.